nstruments

THE MAGAZINE O

Measuremen and Contro

Vol. 16
JAN. 1943
No. 1

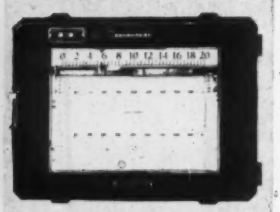
SPECIAL ISSUE :: IN TWO PARTS

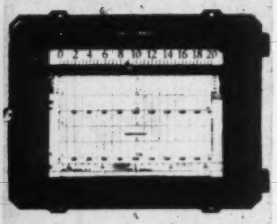
PART ONE

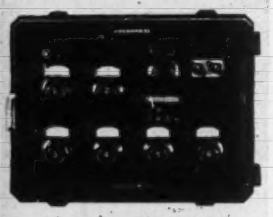
Speeding Up WAR WORK THROUGH Instrumentation

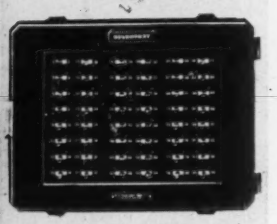
INCLUDING *Aviation Instruments*

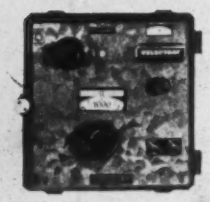
OR MORE SPEED • GREATER PRECISION • LESS W

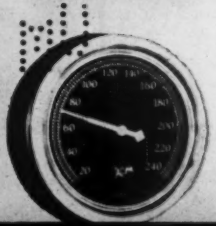












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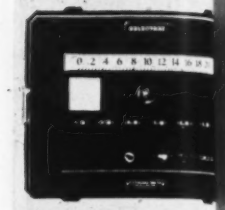

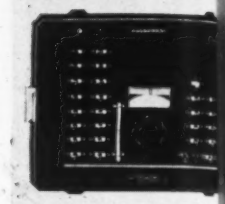

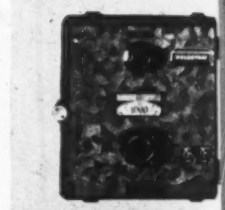

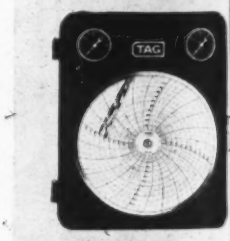

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But with the further development of vacuum tube oscillators and the discovery of increased efficiency of ultra high frequency currents, it became evident that the heater element in the conventional Thermo Ammeter would show "skin effect" at frequencies not then in commercial use, but values which WESTON could foresee in the near future.

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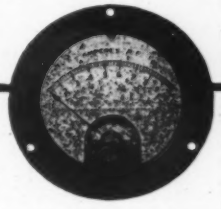
Thus we have the same repetition which so constantly appears throughout the history of instrument progress . . . *a new and improved measurement standard is created, and it bears the same name as the old.* Weston Electrical Instrument Corporation, 591 Frelinghuysen Avenue, Newark, New Jersey.



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Instruments

Vol. 16 JANUARY 1943 No. 1

SPECIAL ISSUE—IN TWO PARTS
(Part Two, bound separately, is *The 1943 Instruments Index*)

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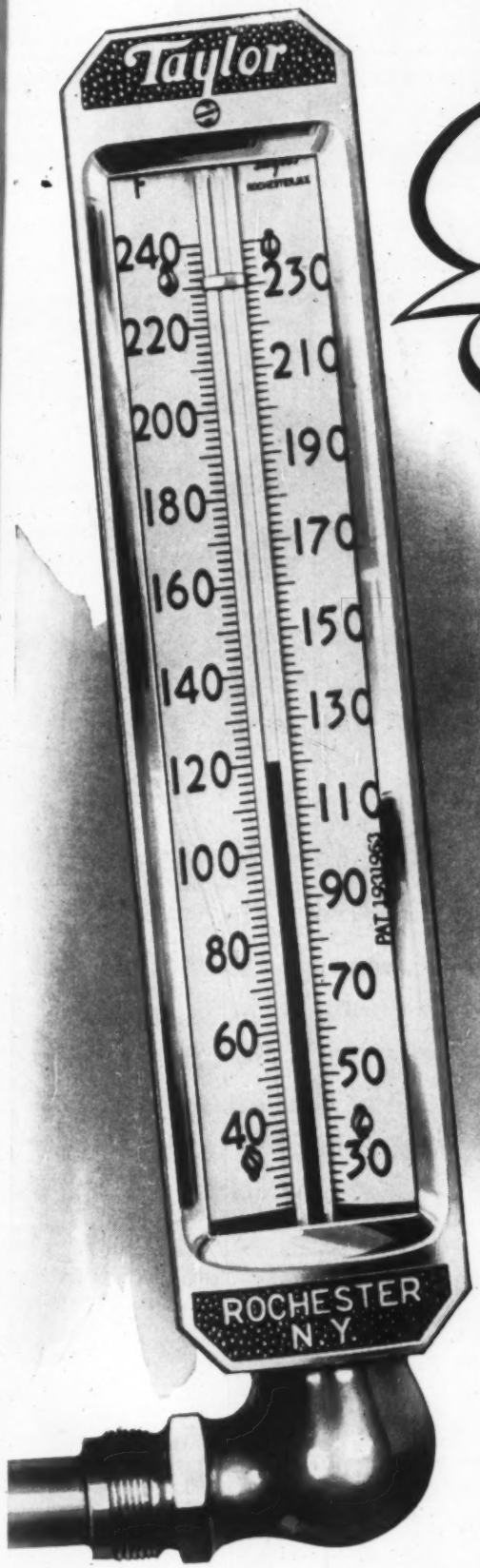
A THERMOMETER THAT TALKS!



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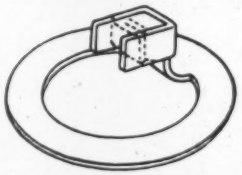

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

War Work Will Be Speeded and American Lives Will Be Saved

THIRTY-THREE articles on speeding up war work appear in this Special Issue of *Instruments*. They were written by subscribers in response to the "Call for Ideas" in the October and December issues. Their lengths range from a short paragraph to a "four-pager." Their subjects touch every major branch of instrumentation. Their applications cover every field of war work. They all deserve to be studied. They WILL be studied and their ideas WILL be adopted. War work WILL be speeded up.

The ultimate result will be taught to future school children—the exact date of Victory. If this Special Issue brings Victory one day closer—even one hour closer—it will have been well worth the efforts of the contributing authors. We have reason to believe (from corresponding with some of them) that most of them cut down their scanty leisure, or even their sleep, to put their ideas into words and diagrams.

This same reason—pressure of work—prevented other authors from finishing in time. We shall print their articles in the earliest possible issues. Indeed, we shall continue to print such articles on speeding up war work: the "Call for Ideas" (October, page 397 and December, page 517) now becomes a standing invitation. Look it up, disregard the closing date but observe the other rules.

In this connection, see page 51 of this issue and bring that notice, likewise, to the attention of non-subscribers who have developed improved methods and devices pertaining to the installation, servicing and repair of instruments, controllers, etc.

It is hoped that red tape will be cut to release without further delay the articles which have been held up by formalities. If censors take long to make up their minds, it probably is because (1) descriptions of important inventions in the field of MILITARY instruments certainly come under the ban; and (2) individual NRC referees or Army and Navy officers whose industrial experience did not include instrumentation are naturally reluctant to take a chance when they see the word "instrument." After a year of doing my little bit in coöperating with the authorities, I am convinced that there's not a military secret in a carload of articles on speeding war work through instrumentation. I may be wrong but I believe that the infallible acid test is, "Does the article describe a hitherto-undivulged NEW PROCESS made possible by modern American instrumentation?" THESE disclosures must not be made without close scrutiny and careful consideration by not one but several censors. On the other hand, industrial speed-up articles such as the ones in this issue (and in subsequent issues) deserve immediate publication and wide dissemination.

It is hoped that articles held up by executives' blind fear of "helping competitors" will likewise be soon released. Such executives (fortunately few in number and influence) are a disgrace to Management and unrepresentative of American Industry. (How petty they seem when compared with the executives who encourage writing for *Instruments* or who THEMSELVES write for *Instruments!*)

Finally, it is hoped that this Special Issue will PROMPTLY start speeding up America's war work. In other words, it is hoped that you who read this (whether a subscriber or on our special-distribution list of high officials and industrialists) will promptly put to work this copy you are holding in your hands: See to it that EVERY IDEA is considered. Some articles contain several ideas.

The only way to look for ideas is to read THROUGH this issue—not necessarily every word of every article at first—then re-read the likely passages; then use more or less imagination according to the degree of similarity between the problems reported by the authors and your own problems. The application of some ideas may not be obvious, but aren't you always eager to do all you can for Uncle Sam in every way? Don't you get a kick out of putting *more* than 10% in war bonds? So give *more* than a casual reading! —M.F.B.

A Historic Occasion

"Even today we are flying as much lend-lease material into China as ever traversed the Burma Road, flying it over mountains 17,000 feet high, flying blind through sleet and snow."—*President Roosevelt in his Message to Congress, January 7, 1943.*

Next to the Constitution, Declaration of Independence, Emancipation Proclamation, etc., our great national documents are the Presidential Messages on the State of the Union. For the first time, instrument flying has received this highest American accolade—and although I've been crusading against the old term "blind flying," I must admit that the beautifully-constructed sentence would be spoiled if the vivid final clause were edited in any way.—M.F.B.

Better Reading

From now on *Instruments* is better reading (in the eye-saving sense) by reason of larger type. Readers' thanks should go to Publisher Rimbach who ordered your editor to make the change. Having 30% fewer words per page, and fewer pages because of government restrictions, I shall have to give you better reading in the other sense.—M.F.B.

Automatic Temperatures of Crystallization

By GEORGE L. SEAVEY
Lynnfield, Mass.

THERE is a need, I find, to automatize the laboratory that controls the instrumentation of industry. Most of the ideas and advances that we hear about are those that directly act relative to the process. The Chief and Assistant Chief Chemist in the laboratory where I work agree that many ideas that we apply to the process can be used in the laboratory. At present we must use intelligent manpower on laboratory control work consisting of *repetitive routine determinations* that by instrumentation could be done with fewer men or could release the present men to study ways and means of increasing the efficiency of production. This also helps management, now burdened with production efficiency. They could then put more emphasis on maintenance and safety programs.

I have developed one of these ideas for automatic laboratory instrumentation with the thought that it may aid the War Effort.

We have the problem of measuring the purity of certain samples by the temperature dwell at crystallization. The methods consist of agitating

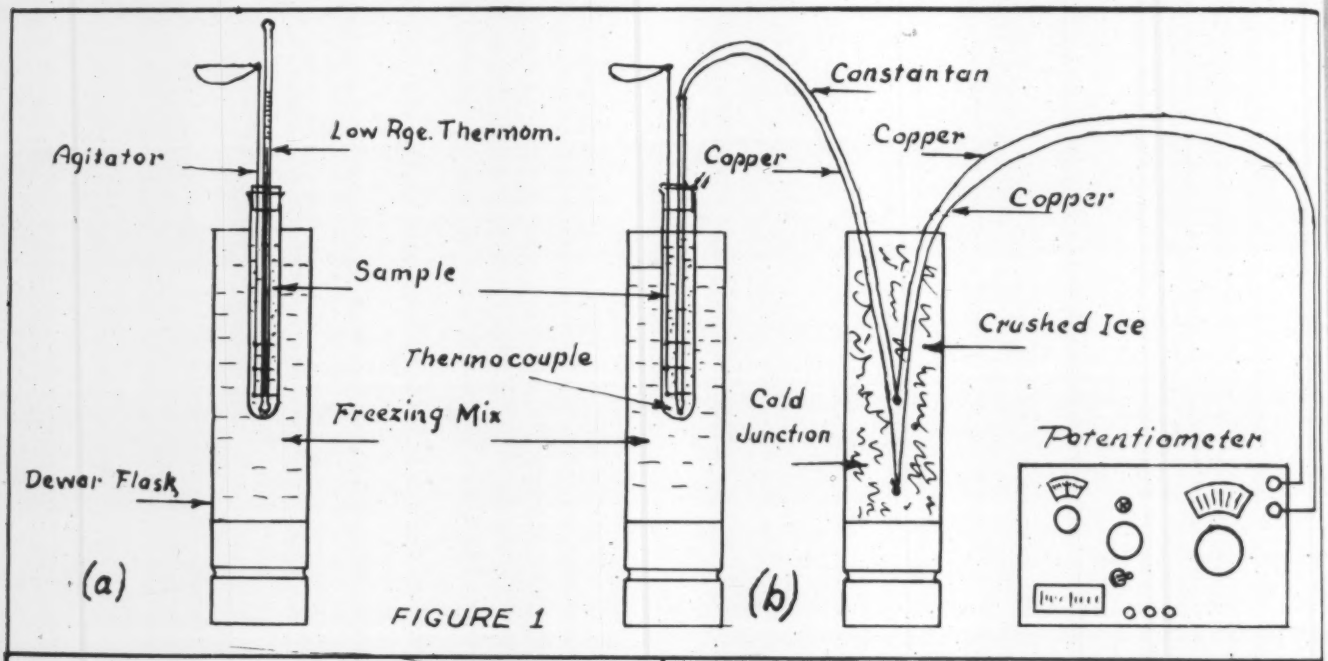


FIGURE 1

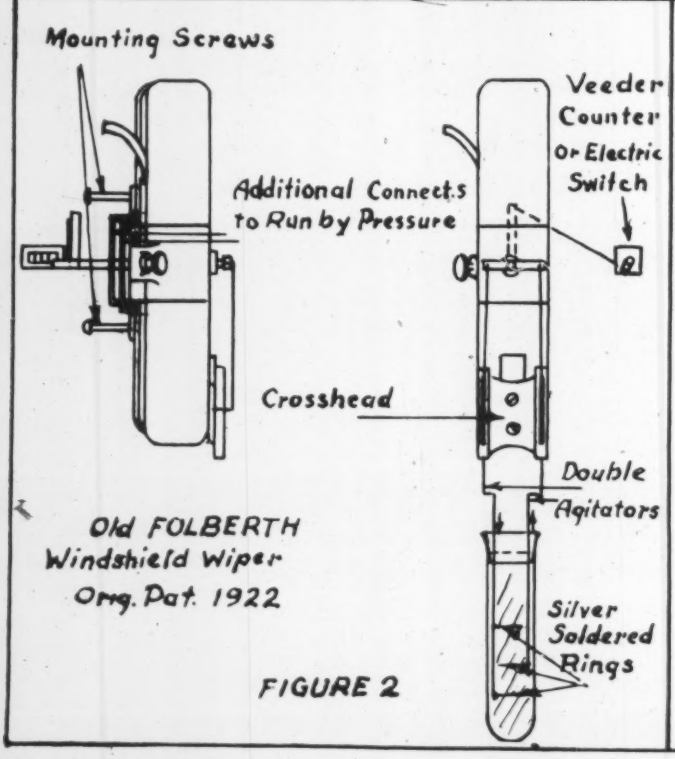


FIGURE 2

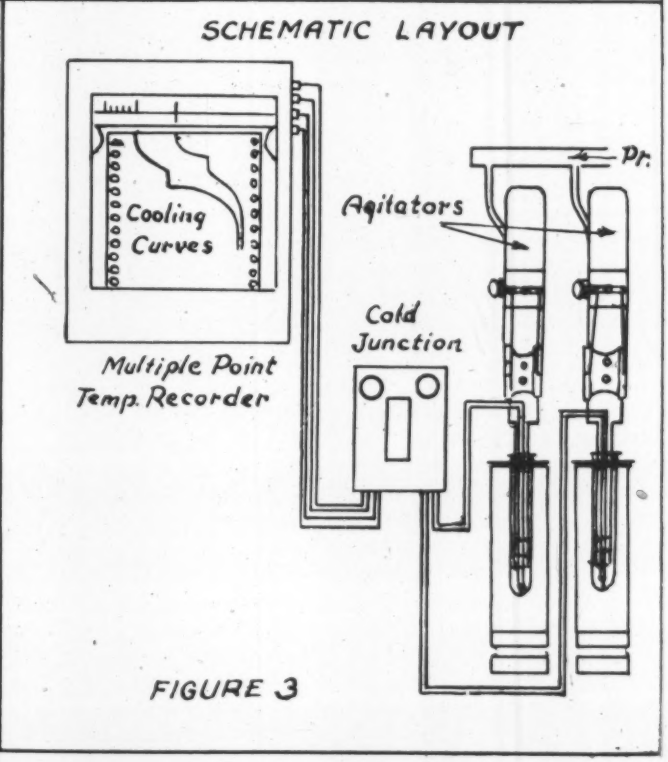


FIGURE 3

the sample, as shown in Fig. 1 (a) and (b), contained in a test tube, which is partly immersed in a Dewar flask filled with crushed solid CO_2 and acetone or some similar freezing mixture. The temperature is determined by either a low-range indicating thermometer or by use of a copper-constantan thermocouple, cold junction and potentiometer.

In the first method one man can do the work, but it tires him if he has many samples and the temperatures of crystallization are low. The second method requires two men as one has to agitate sample and the other manipulate the potentiometer. The second method gives the most accurate results.

Either of these methods uses time, as usually more than one sample has to be run, and in the potentiometric method conversion from millivolts to degrees is necessary.

The automatic version of this job which increases the speed of determination without sacrificing the accuracy consists of the use of agitators, built from old windshield wipers as shown in Fig. 2, and mounted as one unit above Dewar flasks so that, with a multiple-point direct-reading temperature recorder, several samples can be run at the same time. This arrangement is shown in Fig. 3. The advantage of having the complete cooling curves may be appreciated in cases where the dwell temperature, at the crystallization point, is not too prominent and sometimes is missed altogether by our methods of test shown in Fig. 1.

Although I tried agitation by use of a two-lobed cam and follower driven at constant speed by a 60-r.p.m. Telechron motor which gave single agitation, I found that by use of the windshield wiper I gained several features necessary to do this measurement quickly and make the cooling curve on any sample reproducible. These features are: (1) Double agitation. (2) Controllable variable rate of agitation. (3) Device can be made to operate on either suction or pressure with plenty of power. (4) By adding either Veeder counter or electric relay pen on recorder the rate of agitation can be correlated to the cooling curves. (5) If a special gas atmosphere is needed around the sample the agitator can be run on this gas and short line can be run to the sample, minimizing the amount of equipment necessary.

We are planning additional ideas relative to automatic devices on our distillation apparatus, volatile matter determination, feedwater analysis, NH_3 in still waste and liquid level determinations. For this we expect to devise ingenious devices and draw upon plant instrumentation data. I urge all lab men to help the War Effort this way.

Thermopile for Tests of Heating Equipment

By L. W. WINBOLT

Instrument Div., Gas Power Eng'g Dep't, Int'l Harvester Co., Chicago, Ill.

IN order to determine the transfer of heat through a radiator it is highly desirable to measure accurately the temperature differential between inlet and outlet water. Ordinary thermometers or thermocouples reading to one degree are not good enough for this job, since the differential encountered is small—only 4 to 7 degrees in many instances. A thermometer reading to tenths of one degree would be better, but is expensive to replace when broken and is more sluggish in action than a bare-wire thermocouple.

It has been found that a ten-couple thermopile can be made, compact enough to go inside of a standard half-inch diameter copper tube, for insertion in the water passages of a radiator. Ordinary brass "Hi-duty" fittings may be used, as shown in Figs. 2 and 3. No. 24 iron, constantan and copper wires are used as shown in Fig. 1 to make the thermopile. Junctions are in series. An independent couple is included in each junction of the pile and leads run to a three-position switch, one position being reserved for the thermopile itself. From this switch iron and constantan leads are run (from the two positions connected to the independent couples) to a potentiometer; copper leads run from the cold junction of the thermopile to the switch and thence to the potentiometer. The switch must be of double-pole type.

The above-mentioned independent couples are included in the set-up to enable the operator to get a rough check at all times on his readings; and they also serve to determine actual inlet and outlet water temperatures to the nearest one or two degrees. The thermopile will read to one-tenth of a degree or better, assuming that the potentiometer used with it is graduated directly in degrees. Potentiometer cold junction temperature is read preferably with a 0° to 120°F. thermometer, reading to one degree, inserted through a grommetted hole in the side of the potentiometer case in such a way that it can be pulled out slightly for reading.

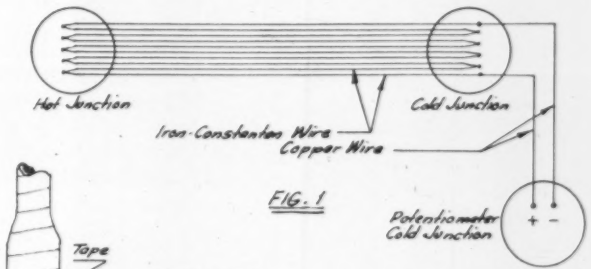


FIG. 1

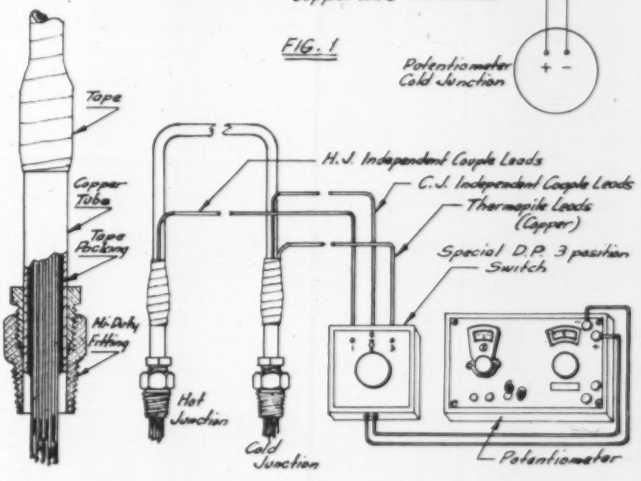


FIG. 2. FIG. 3

The thermopile will read room or potentiometer

cold junction temperature plus ten times the temperature differential between its ten hot and ten cold junctions, if the potentiometer reads in degrees. An instrument reading in millivolts would merely require a set of conversion table readings and would be found no more accurate and considerably more inconvenient than the direct-reading type.

Our potentiometers are calibrated in degrees and have automatic cold junction compensation. Some question having arisen as to the accuracy of this compensation, repeated tests have not shown more than ±1°F. error in reading of both room and water boiling point temperatures over a cold junction temperature range of 60°F. to 110°F. Thus the pile could not read more than 0.1°F. off for this cause.

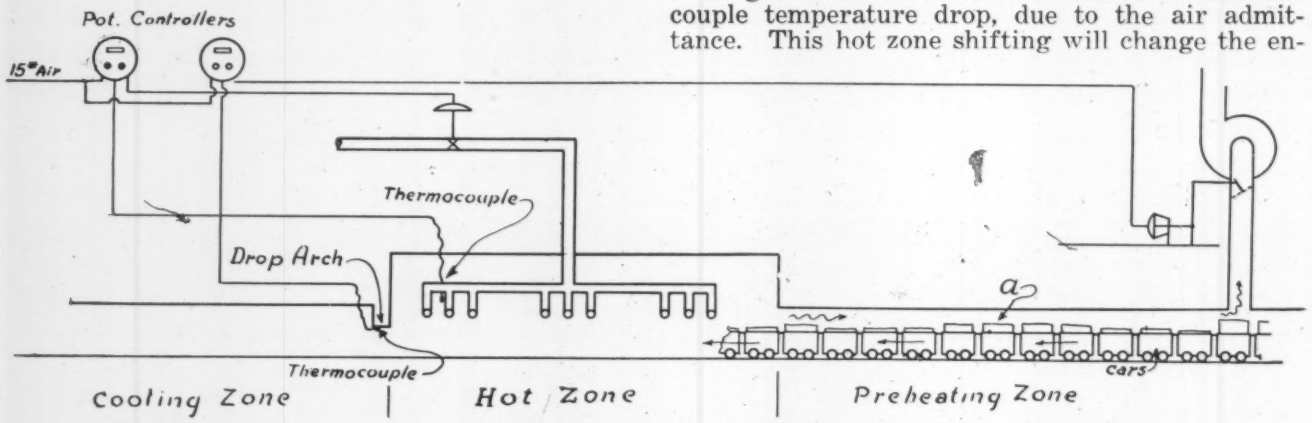
Likewise, a reading error of 1°F. on the instrument cold junction would cause a 0.1° error in pile reading. If a reasonably good thermometer is used here and all readings are carefully made, it seems not too much to expect accurate readings (to one-fiftieth of a degree) of the temperature differential. Such a pile has a fast response and it is easily possible to study the action of radiator thermostats with this set-up.

Automatic Kiln Draft Control with Thermocouple as Primary Element

By O. J. PARRETT

Instrument Dep't, A. C. Spark Plug Co., Flint, Michigan

ONE control problem has been solved in an out-of-the-ordinary manner in our plant, but this same idea may be used somewhere else. The problem was to control draft of a continuous tunnel kiln. Due to the construction of the kiln it was quite a problem to use a draft control and, as it was more or less of an experimental job, we decided to use what equipment we had on hand. This equipment consisted of a Foxboro potentiometer type air-operated controller and damper motor.



The temperature of the kiln is controlled at 1430°C. ±2° by another Foxboro potentiometer Stabilog. The ware first travels into the pre-heating zone then to the hot zone, and finally through the cooling zone. Between the hot zone and the cooling zone is a drop arch (see sketch) which tends to separate the two zones as it is the lowest part of the kiln roof. At the loading end we have a fan connected to the area above the ware which tends to draw the burned gases over the incoming ware for pre-heating purposes. This fan is constant-speed so that as the area at *a* is changed, due to the different types of ware being loaded, the volumes of gases that the fan can handle will vary because of this change of area.

As the volumes of gas and air being supplied to the burners are someewhat constant, this change of exhaust will create a slight pressure or vacuum in the hot zone. This change of pressure will either draw in cool air under the drop arch or exhaust hot gases.

Because of the location of the thermocouple—it is located in the hottest part of the kiln—this infiltration of cool air tends to shift the hot zone toward the loading end as the controller will allow more gas to the burners to overcome the thermocouple temperature drop, due to the air admittance. This hot zone shifting will change the entire heating curve of the furnace, causing the ware to mature sooner than desired, and also subjecting the ware to excessive heat shocks due to the sudden change in temperature.

After an exhaustive study was made of the problem, we decided that if a thermocouple was placed in the opening below the drop arch, it would give a good indication of the temperature changes involved, as the drop arch is more or less a divider of extreme temperatures. This was done and, to our surprise, we found that as much as 200°C. changes were taking place. It was then a simple control problem, so we installed the air-operated controller on the job. As the temperature at the drop arch starts to fall, the controller closes the damper in the exhaust pipe enough to compensate for the additional vent created by the loading of lower ware.

As a result of this installation we were able to reduce the gas consumption and maintain better firing conditions in the kiln.

Here's More Proof

that the RIGHT instrument makes trouble shooting a CINCH

Mr. Rusfeldt is using his AK-1 to locate the damaged coil after tracing the grounded-coil bank.

READ how the RIGHT instrument helped Mr. A. Rusfeldt, electrician at the Michigan Alkali Quarry, save valuable production time:

"A surge grounded a coil in our crusher motor. There were no visible smoke marks or splashes to show where to look for it. We started to use the old-fashioned test of opening connections and ringing with a magneto. Then I realized that this was just the job for our G-E AK-1 hook-on instrument.

"With a resistance connected in series with the winding, we ran current (110 volts, a-c) through the winding to ground. We then traced out the grounded bank of coils by clamping on over the jumpers. On the third try we found it."

Green Hands Make It Even More Necessary to Have the RIGHT Instruments

An experienced man like Mr. Rusfeldt could have found the trouble without the AK-1 (described below). But it saved him time—valuable crusher production time.

How much more important to have the RIGHT instruments for your inexperienced men! They don't know the short cuts and ingenious ways of testing electric equipment. It will pay you to be *sure* you have all the instruments needed for your maintenance work.

HERE'S HOW WE CAN HELP YOU

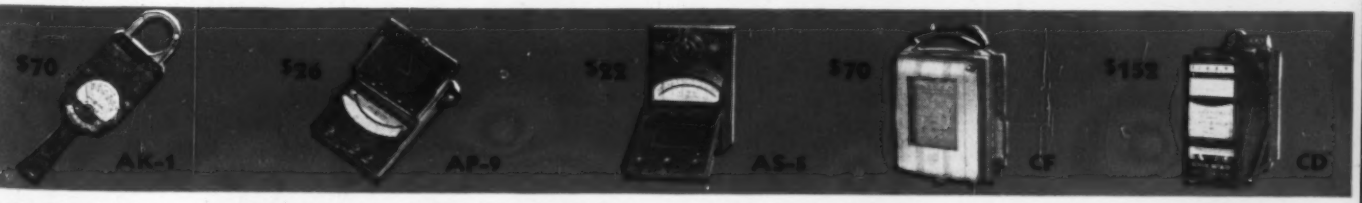
1. *If you need* a testing instrument, the five shown below will do 90 per cent of all testing jobs (prices are for estimating only). Bulletins listed give complete data.

2. *If these do not answer*, tell us what you need. The chances are we can send you a bulletin describing just the instrument for your purpose.

3. *If you'd like help* in selecting an instrument for a specific job, call the nearest G-E office. One of our instrument men will be glad to assist you.

General Electric Company, Schenectady, N. Y.

WHICH OF THESE TESTING INSTRUMENTS DO YOU LACK?



-C HOOK-ON VOLT-MMETER. The handiest of truments for quick load checks no cutting conductors or inter-bling service. Measures volts to. Bulletin GEA-2950.

MEDIUM-SIZE PORTABLE, A-C (AND DP-9, D-C). Accurate within ¾ of one per cent. Very portable—size only 2½ by 6½ by 4¾ inches. Price covers a 5-amp ammeter. Bulletin GEA-1784.

POCKET-SIZE PORTABLE, A-C (AND DS-5, D-C). Accurate within one per cent. Slips easily into a coat pocket—size 2 by 3½ by 5½ inches. Price covers a 5-amp ammeter. Bulletin GEA-1784.

INKLESS RECORDER, PORTABLE. An inexpensive instrument. Inkless—no pen to start and no ink to spill. Price covers a 5/10-amp ammeter. Bulletin GEA-3187.

INK RECORDER, PORT/ AND SWITCHBOARD. for use where a high degr accuracy is very important. covers a 5-amp portable meter. Bulletin GEA-1061.

GENERAL ELECTRIC

602-41-8200

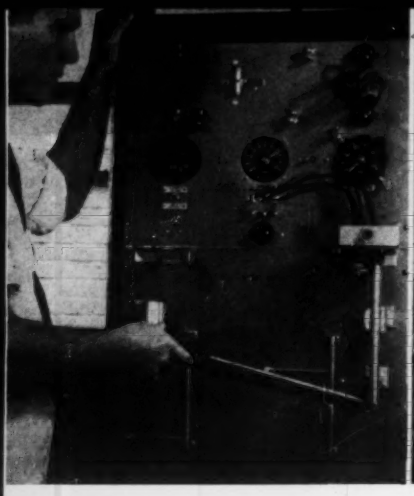


Fig. 1

Fig. 2

Fig. 3

Instrumentation Aids United Air Lines to Set New Records in Air Transportation

By W. C. MENTZER,
Chief Engineer, United Air Lines, Chicago, Ill.

NEW records for passenger, mail and express traffic are being established, month by month, by United Air Lines as our company, along with other airlines, provides the vital element of speed in the transportation of essential military and civilian traffic.

United's figures for 1942 show estimated gains of 8% in revenue passenger miles, 81% in mail ton miles and 130% in express ton miles—despite a decrease of 16% in revenue airplane miles flown. This achievement in moving record passenger-cargo loads with *a fleet 40% smaller* than that of 1941—a reduction due to the turning over of a number of planes to the government for military missions—was made possible in large part by improved maintenance.

An important feature of United's maintenance work always has been that linked with aircraft instruments. Along with every other phase of maintenance, that of instruments has been steadily improved through the development of new devices and methods. Portions of United Air Lines' instrumentation story have been told from time to time in previous articles prepared especially for *Instruments*. Time does not permit my bringing this story up to date and in full—and perhaps the editor could not find room for the complete story anyway. Only five examples will be given (briefly and mostly pictorially) and these will only be examples of special-purpose instruments.

The instrument overhaul and repair shop at our central maintenance base in Cheyenne, Wyoming, which was described in the December 1939 issue of *Instruments;* and our Communications Laboratory have both continued to design and develop (and in some cases to manufacture) special apparatus for rapidly and accurately testing and calibrating various types of aircraft instruments and aircraft radio equipment.

Fig. 1 shows a fuel quantity test panel used for testing all parts of the fuel quantity indicator system in a Douglas DC-3 plane. On the panel are mounted parts of the indicator system, including the tank unit, stroke adjusting assembly, voltage compensator, and indicator. This test device makes possible an accurate calibration of the instruments and provides a gage of performance under simulated operating conditions.

In Fig. 2 is shown a twin indicator test stand which permits accurate checking of turn indicators under simulated operating conditions. A saddle holding the indicators is turned by a synchronous motor at a rate of 180 degrees per minute, which is United's standard rate of turn. A friction clutch is provided for convenience in checking the instruments for general operation. The device is connected to a manometer by means of which it is possible to check the vacuum which operates the instruments.

In Fig. 3 a device used for testing air speed indicators is shown being operated by W. M. Bartosch, also in the instrument shop at Cheyenne. It consists of two columns, one covering a range from zero to 270 miles per hour; the other from zero to 450 miles per hour. Air is introduced to the columns at pressures equivalent to those encountered at air speeds of from zero to 240 miles per hour and the indications of the air speed indicator are made to correspond with those of the column. A spring-operated cylinder, controlled by a lever in front of the panel, creates the air pressure which, in turn, actuates the liquid in the two columns and the instrument simultaneously.

The other two photographs illustrate devices produced by the communications laboratory for use in service shops along United's routes. Fig. 4 shows a signal generator for aligning and measuring the frequencies of all radio receivers carried aboard United's Mainliners. The equipment is made for the operation of twenty-four crystal-controlled frequencies but can be adapted to as many as forty. It has an output ranging from one millionth of a volt to one volt and is capable of modulation up to 100 percent at six different audio frequencies.

E. A. Jensen of the communications laboratory, who designed the equipment, is pictured operating the push buttons which permit selection of crystal-controlled frequencies. The design of this signal generator was necessitated by the steady increase in the number of frequencies being employed in aircraft radio communication and navigation.

Fig. 5 shows a vibration generator for testing radio equipment under conditions considerably in excess of those encountered in flight. An air-operated generating unit with an electrical frequency control is connected with a test table which can be rotated through 360 degrees for inspection of equipment during test. A means is provided for increasing or decreasing the amplitude of vibration, with a maximum intensity of 3 *g*-units for a 100-lb. load. The frequency of vibration is constant at 30 cycles per second. H. N. Wilcox, of United's communications laboratory, who developed this vibration generator, is shown putting a receiver through a typical test. The device provides a scientific means of determining the susceptibility of a radio set's operation to vibration as contrasted with previous methods which sometimes proved inconclusive and potentially harmful to radio equipment.

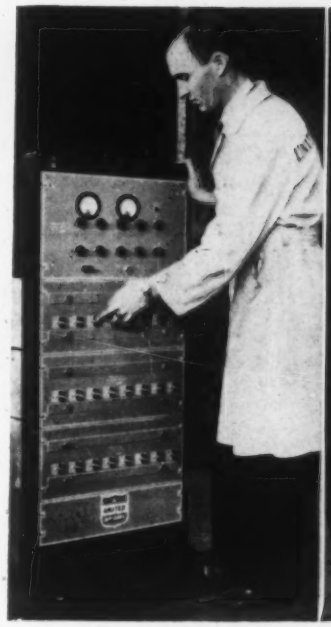
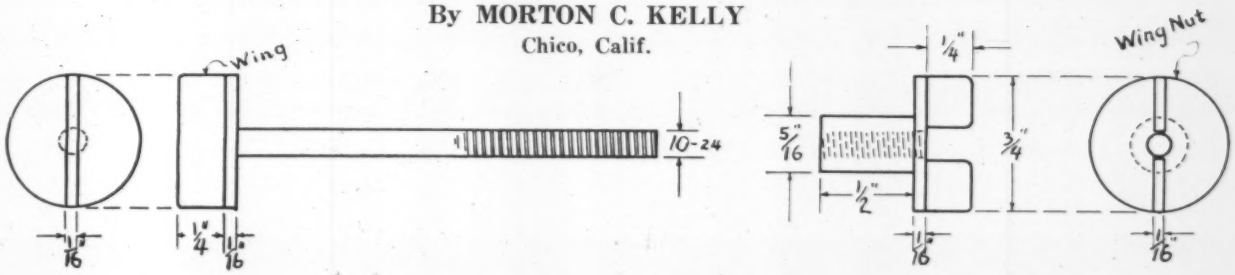


Fig. 4

Fig. 5

Speeding Up the Assembly of Gyro Instruments

By MORTON C. KELLY
Chico, Calif.

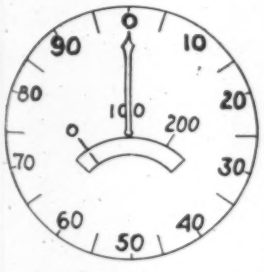


HERE is a drawing of a tool which I find of real value in assembling the gyro bearings in a bank & turn indicator. Anyone who has fought the lock rings as we have can readily appreciate its use. The illustration is full-size and self-explanatory. Since this is a new device it has to be named. Its technical designation is "Compressor for Bank and Turn Bearing Corrugated Washer" but I think that some gyro instrument men will call it "My Favorite Speeder-Upper."

Simplified Two-Pointer Arrangement

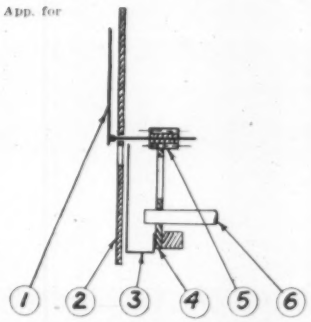
By OTTO WEIL
504 West 111th Street, New York City

ON semi-sensitive altimeters and airspeed indicators, two pointers are needed. The problem of designing the second pointer is solved for sensitive and expensive instruments. The following description may show a simpler and cheaper device for semi-sensitive altimeters and airspeed indicators.



1. Pointer 2. Dial

Pat. App. for



3. Wire 4. Sector gear 5. Pinion gear 6. Rocking shaft

The second or "slow" pointer is a wire (3) with a radium-painted tip which is visible through a slot in the dial (2). The end of the wire is soldered to the sector gear (4). The wire moves through the same angle as the sector gear, thus serving as a second pointer.

This arrangement does not increase friction or interefere with the bearings of the rocking shaft. Total weight of wire and solder-drop is negligible as compared with that of a mechanism. Time of fabrication is believed to be the irreducible minimum because simplicity is carried to its utmost.

Rapid Method and Apparatus for Type Testing in Aircraft Instrument Production

By PAUL S. WHITE
Inspector, [dep't and plant censored], La Crosse, Wis.

TYPE TESTING, that is, the actual functional performance of an aircraft instrument under all sorts of atmospheric and vibration conditions, is perhaps the most important phase of modern aircraft miscellaneous inspection.

A percentage check must be conducted for A-N standards and it must present a thorough, highly accurate yet practical log of all performance under conditions simulating actual flight.

In order to facilitate operation and actual reading of these instruments, various commercial racks and manifolds have been built and used successfully in conjunction with master gages and manometers for comparison.

Speed in operating this test must be considered if maximal rate of production is to be maintained. Fig. 1 illustrates a method which has proven highly successful in meeting the varied requirements of such instrumentation. Nitrogen is used as the pressure-testing medium. This prevents any moisture from creeping into the Bourdon tubes of the pressure gages; and also provides a means of testing the units under extreme hot and cold—this being accomplished by the use of an easily-removable box-like cover (suspended directly over the test manifold) which may be raised or lowered at the operator's convenience. The temperature is lowered by the addition of dry ice to a small attached container; or raised by turning on an electrical heating unit likewise built into the cover. The air is circulated by a blower at one end.

The entire test manifold is built on and around a vibrator unit which may be turned on or off at the will of the operator, thus obviating the need of removing any gage during the type test.

In constructing the manifold, it must be taken into consideration that a prime factor is ease in mounting the instruments without danger of stripping or injuring the threads as may be easily caused by the use of an oversize fitting or too much pull required in tightening.

Illustrated in Fig. 2 is a manifold connection provided with a thumb-screw fastening and pressure-tight socket which will prevent mishandling and also provide quick easy mounting or removal.

A large number of gages may be safely tested at the same time without any fear of leakage or breakage, thus making routine testing a production operation rather than a slow-down operation.

A vacuum pump is mounted directly underneath the manifold for use in leak testing of cases and also for vacuum gages.

For thermal units, a small though efficient constant-temperature bath is conveniently placed at the rear of the test manifold. It is thermostatically controlled and a cross check on each bath is provided by a Bureau of Standards certified mercury thermometer.

The bath liquid medium is circulated by a jet of air which may be hand-regulated for the highest operating efficiency. An approved employee reads and records the test while sitting on a chair provided with rollers which enables him to shift back and forth but always maintain the same eye level. This is important in reading instruments.

A system of this sort is well worth any time, money or effort that its installation might require, as it provides for an accurate, speedy, yet systematic check which coördinates with inspection, so that any cause for rejection may be detected immediately, thus allowing for a change if necessary, and scarcely hindering the production line.

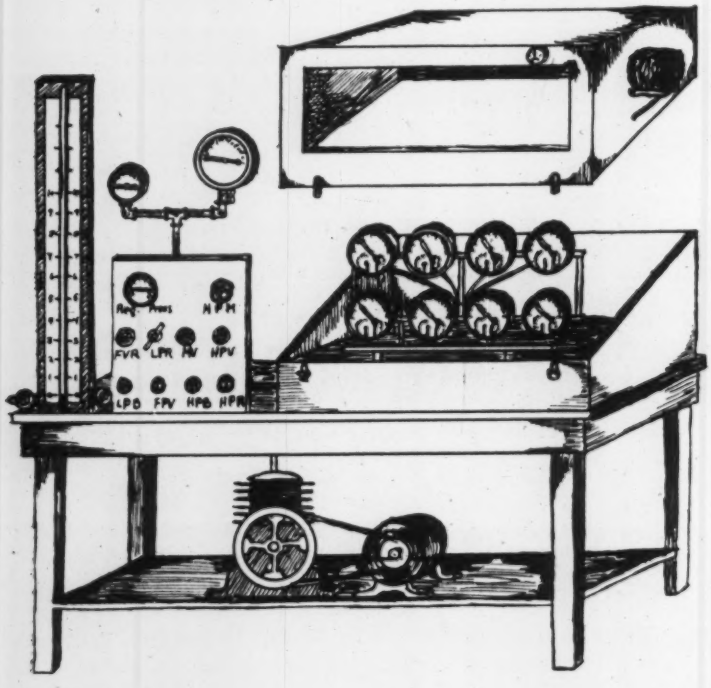
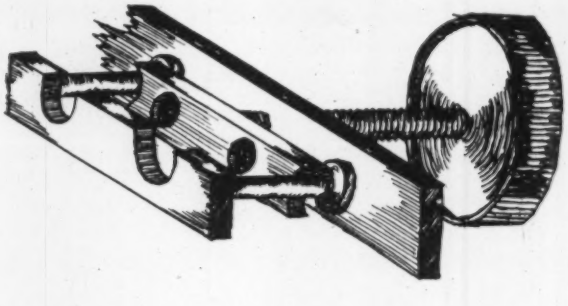


Fig. 1 (left)

HPM—High pressure to manifold
FVR —Fuel vacuum regulator
LPR —Low-pressure regulator
MV —Master valve
HPV—High-pressure valve
LPB—Low-pressure bleed valve
FPV—Fuel pressure valve
HPB—High-pressure bleed valve
HPR—High-pressure regulator

Fig. 2 (below). This permanent fixture is part of the manifold. It is capable of mounting two gages with a thumb-screw adjustment for tightening the slide bar with two corresponding holes drilled in it and a gasket provided for a leak-proof connection. An adapter fitting is used for female thread.



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Yet this tiny movement—an average of only .00009 of an inch for each 20-ft. calibration—sends the large pointer around the dial 50 times for a lateral travel of more than 37 feet.

At lower altitudes, control of expansion is a relatively simple matter. But as the troposphere and stratosphere are reached, each 1,000 feet of climb multiplies rapidly the problem of precise barometric measurement and temperature compensation.

Such an instrument is the highest expression of Kollsman precision work and forward-looking policy to keep abreast of the finest military aircraft today . . . to build for the future when passengers, mail and cargo will be carried 50,000 feet in the sky.

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Automatized Inspection of Aircraft Electrical Instruments Triples Testing Speed

By BRANT CONWAY, A. C. EMERY and C. S. GOOCH
Chief Instructor Instructor Instructor
Shelby County School of Aeronautics, Whitehaven, Tenn.

1. INTRODUCTION

USES of electrical instruments are becoming more numerous as each day goes by, and this results in more of a load on our "green" and rapidly-expanding aircraft instrument overhaul departments. Each new instrument requires quite a bit of basic study as to its design and electrical characteristics when being overhauled and inspected. Instead of taking a great deal of time and a large quantity of equipment in setting up of calibrating standards each time the instruments are to be checked, we at Shelby County School of Aeronautics have developed a number of pieces of standard equipment with which a great saving of inspection and calibrating time is obtained.

2. GENERAL DESCRIPTION

These calibrating standards are usually each designed for one particular type of instrument such as Cylinder Head Temperature Indicators, Fuel-Air Ratio Indicators, Ratio Thermometers and the like; and can be used to a great advantage in production testing and inspection of aircraft electrical instruments. They are built and designed so as to be readily portable, small, and flexible in use, and as near as possible fool-proof and safe as regards to possible damage to the equipment and instruments due to overloading, etc. Usually a number of functions of the instrument are checked by the flick of a switch and some nine functions are easily possible as in case of some Fuel-Air Ratio Indicators (as Fig. 1).

The same general type of construction is used for the standards as is used in the common radio tube checkers. The instrument to be checked is connected by socket, plug or harness to the test standard, thereby eliminating a chance for reverse wires, burnouts, shorts, etc. The various parts are selected or built to as high an accuracy as is possible and when completely aassembled the unit is adjusted to an overall accuracy of as good if not better than the method of connecting up decade boxes, batteries, indicators. When these standards are used daily for different functions by new mechanics (and even older and more skilled mechanics) there is always present a chance for some inaccurate hookup, reading or adjustment which if overlooked would result in imperfection. Also, each different user of the assembled equipment has a chance to make a different error and, as a whole, a wide variety of finished instruments would result. In cases of too few available standards (very common at any particular shop) any instrument or piece of equipment damaged or ruined would slow or impair other groups having to rely on the same standards. All this has been eliminated by the individual testers; for each different hookup has been previously adjusted and the operator has only to throw the desired switch and note the readings of his instrument.

In the case of the "Wonder Worker" (Fig. 7) we can check at least three different varieties of engine instruments, namely: (1) Cylinder Head Temperature Thermometer, thermocouple type; (2) Ammeters with 50- and 100-millivolt sensitivities, using external shunts; and (3) Fuel-Air Ratio Indicators. Also available is a Millivoltmeter with adjustable range of from 10 to 1000 millivolts. All of the parts used were common to the supply of your radio equipment jobber, and were inexpensive in cost. The resulting accuracy is under 1% which is 100% better than the rated accuracy of the aircraft instruments to be checked.

The construction of each unit centers around an old radio-frequency galvanometer which is used as the basic millivoltmeter and has been reworked to an accuracy of ½ of 1%.

The various settings of the switches connect different values of voltage through resistor networks and are routed to the different terminals. Damage to the standard instrument itself is eliminated by the automatic selection by the selector switch of proper voltages and indicator ranges for the particular application. In other words, any possibility of the operator putting too much voltage on his instrument or the standard is eliminated.

We have found that an overall time saving results in speeding the work about 300% and in a greater consistency of accuracy.

3. INDIVIDUAL DESCRIPTIONS

A small portable unit for quickly testing Cambridge Fuel-Air Ratio analysis cells is shown in Fig. 1. It is semi-automatic by reason of self-contained battery, indicator and switching arrangement which eliminates errors in connections, with

Fig. 1

consequent saving of time. The unit is essentially a balance indicator, with provision for setting total current through the cell spirals to a constant value before testing for balance. In use, the cell is connected to the four pin jacks numbered 1 to 4 respectively, corresponding to the four binding posts (or numbered pins on Cannon plug) on the cell assembly. With the toggle switch in the 200-milliampere position the current is adjusted to 180 ma. which is the correct value according to manufacturer's specifications. Then the switch is changed to the 1-ma. position and balance can be checked on the same indicator. A cell which will show balance on this unit will calibrate when connected to the test panel in the next photo.

A panel mounted unit for gassing and calibrating Cambridge exhaust gas analyzer cells and Fuel-Air Ratio Indicators is shown in Fig. 2. It

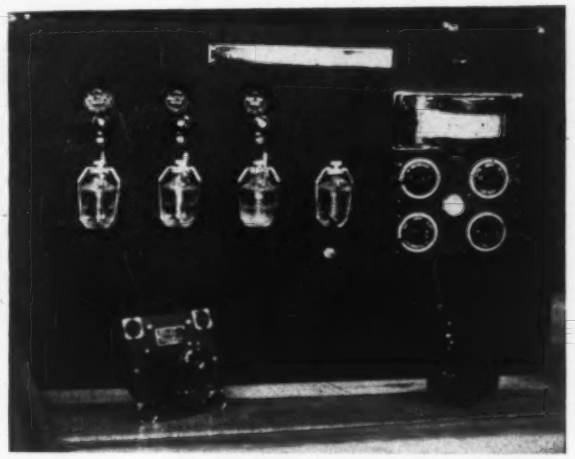


Fig. 2

incorporates a Cambridge master cell and indicator, with provision for mixing air, hydrogen and carbon-dioxide gas in proper proportion to provide any reading desired. After the mixed gas passes through the master unit, which is self-calibrated, the same gas is introduced into the cell (or cells) under test, and adjustments made to cause the reading of all cells to be the same, with constant gas mixture. Needle valves and bubblers assist in accurate adjustment of the various gases. By use of a fourth bubbler an automatic leak test is obtained. In use, the cell under test is connected to the master unit, with the heated spirals (terminals 1 and 4 on the cell) connected in series with the battery which furnishes power for both the master and the cell being tested. Terminals 2 and 3 connect to the binding posts which allow the master indicator to read either from the master cell or the cell under test. Provision is also made for connecting indicator units being repaired, and proper adjustment made to show readings which will coincide with the master. With this equipment one operator can test and adjust ten or more cells per hour.

Fuel-Air analysis indicators manufactured by Breeze and Engelhard make use of a plug-in type of ballast tube which regulates the current through the cell to a constant value regardless of battery voltage, within reasonable limits. To test these tubes for operating characteristics requires open-

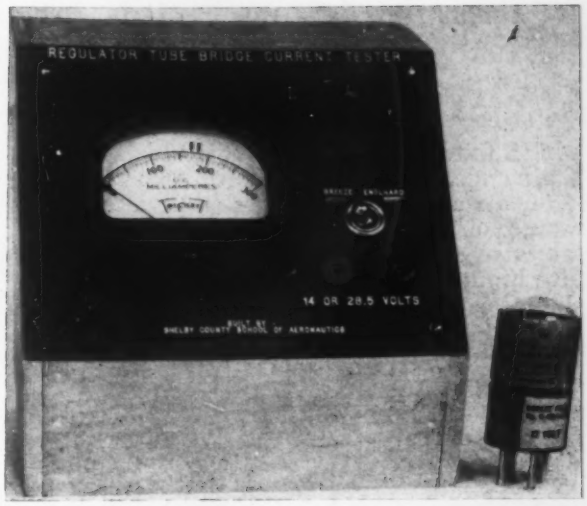


Fig. 3

ing the circuit to install current meter. With the simple portable test box illustrated in Fig. 3, the ballast tubes are checked in a manner similar to the testing of radio tubes in an ordinary tube-checker. External voltage supply of 14 or 28 volts may be connected to the test box and the ballast tube inserted in the socket provided. The proper load is automatically connected and the current indicated on the milliammeter. Limits for the current are marked with colored flags on the dial of the milliammeter. The switch marked "Breeze-Engelhard" is also color-coded to correspond with the flags on the instrument face. The width of the marking on the dial includes the limits within which the tube should control the current.

Fig. 4 illustrates a portable unit for testing Weston temperature bulb resistance elements, which will make all tests necessary to determine whether the bulb is satisfactory for further serv-

(Continued on page 36)

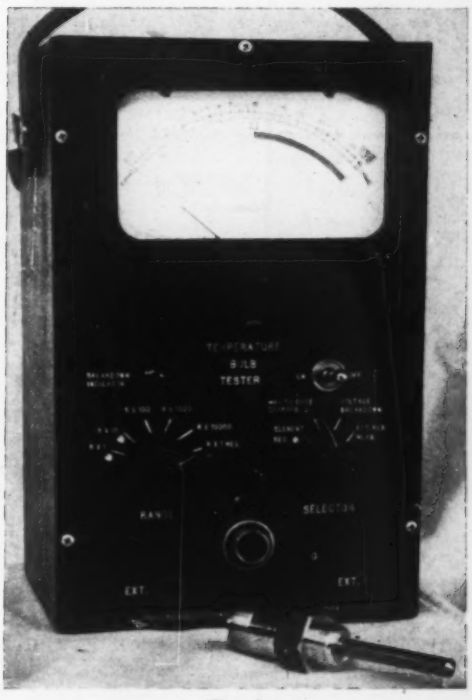
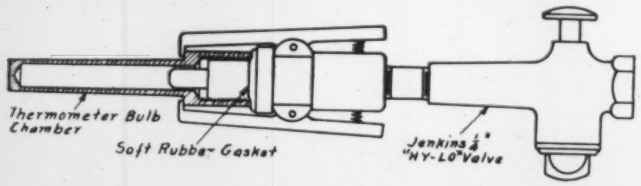


Fig. 4

Pressure Testing Fixture for Threaded Chambers

By ARTHUR A. HULL
Sup't of Inspection, C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.

THIS fixture consists of a two-jaw rubber-seated air chuck with a standard button type air nozzle for air control. It obviates the need of screwing on and off thread and eliminates wear on seat otherwise contended with to make air-tight under quite high pressures.



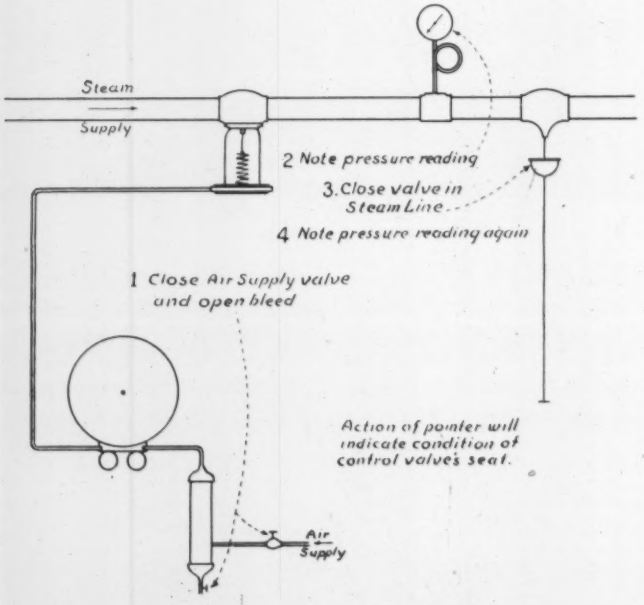
The chamber is centralized and clamped against a rubber enclosed seat and held by the spring-closed jaws by a slight pressure on the end of chamber; and released by hand pressure on spring ends of jaws.

This fixture easily speeds up testing by 600 percent and eliminates all wrenches, clamps, etc. Leaks may be easily detected when fixture is placed in tank of water.

Quick Inspection of Automatic Control Valve Seats

By WILLIAM D. MacEVITT
Bound Brook, N. J.

AN easy and accurate field test for control valves may be performed in a few minutes as follows: Shut off air to control head—preferably at air receiver as this guarantees that the control valve (air to open type) will be closed.


Steam
Supply
2 Note pressure reading
3 Close valve in Steam Line
4 Note pressure reading again
1 Close Air Supply valve and open bleed
Action of pointer will indicate condition of control valve's seat.
Air Supply

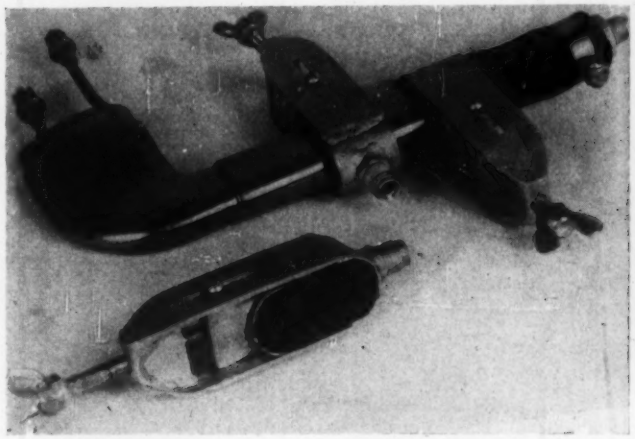
Globe valves are generally located both up- and down-stream from the control valve. The one on the down-stream side is normally little used. A pressure gage in the line between it and the control valve forms the combination necessary for this test. Simply close that valve and see if the pressure builds up. If it does, the control valve is leaking through the seat. The question, "How much?" is answered by how fast the pressure builds up.

"Preventive medicine" such as this eliminates production hold-ups.

Pitot Tube Test Fittings

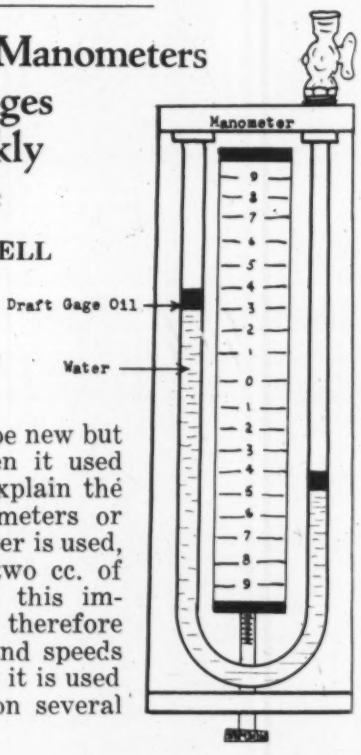
By SID H. STICHAL
Foreman, Instrument Installation, Sacramento Air Depot, North Sacramento, Calif.

SHOWN in the photograph herewith are fittings used on aircraft Pitot Heads to run air-speed static and pressure system checks and calibration tests. These fittings have proved to be an improvement over the type of attachment fittings formerly used at the Sacramento Army Air Depot. They have been in use for the past year. They provide an affective means of attaching a portable test unit to the Pitot Head and consequently to the air-speed static and pressure systems for quick calibration checks and tests of air-speed, altimeters, and rate-of-climb indicators.



Making Water Manometers or Draft Gages More Quickly Readable

By C. D. MITCHELL
Tulsa, Okla.



THIS idea may not be new but I haven't ever seen it used before so I'll try to explain the advantages. In manometers or draft gages where water is used, if you place one or two cc. of 0.827 draft gage oil, this improves visibility and therefore it saves many steps and speeds up whatever operation it is used on. We are using it on several applications.

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Rapid Non-destructive Material Testing with the Cathode-ray Oscilloscope

By W. A. KNOOP, Jr.
Allen B. Du Mont Labs., Inc., Passaic, N. J.

IN many situations it is desired to inspect seemingly identical pieces of material in order to detect small differences in their magnetic, conductive and dielectric properties. These properties are often governed by the chemical content of the material. An analysis is usually destructive and time-consuming, and it requires skilled operations. Apparatus has been developed which consists of a conventional audio oscillator, a simple bridge circuit to convert variations in the aforementioned characteristics into intelligible variations of electrical waveshapes, and a standard Du Mont "Type 208" cathode-ray oscillograph as an indicator of the waveshape variation.

A circuit diagram showing a typical circuit configuration appears in Fig. 1.

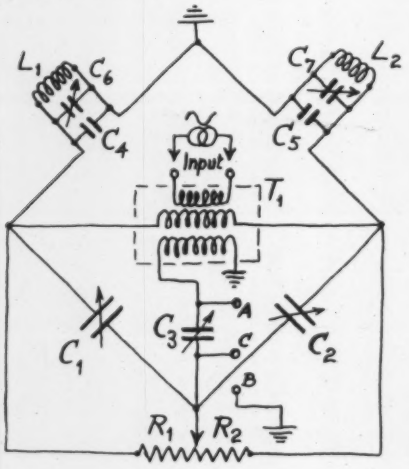


Fig. 1.

Connect Terminal A to horizontal input post on cathode-ray oscillograph.
Connect Terminal C to vertical input post.
Connect Terminal B to ground posts.

The bridge circuit is balanced at the fundamental frequency at which the oscillator is set and the two test-coil tuned circuits, L_1 C_4 C_5 and L_2 C_5 C_7, are tuned to resonance at the third harmonic of the fundamental. A third harmonic content is assured by driving the impedance-matching transformer T to the overload point. For the circuit components as specified below, the oscillator must produce a signal voltage of approximately 200 volts. If a signal composed primarily of a fundamental component such as that available at point AC is applied to the horizontal deflecting axis of a cathode-ray oscillograph; and a signal consisting of the fundamental and a large proportion of third harmonic content is applied to the vertical deflecting axis, a trace will be produced resembling Fig. 2 to the left. The exact adjustment of the bridge components is rather critical if that desirable pattern is to be produced, but once it is accomplished the controls may be left stationary for a given type of sample. If there is a disturbance of the resonant condition of the test-coil tuned circuit after the circuit is once adjusted, the osculating lobes will either move apart or cross over each other, depending on the nature of the disturbance.

Resistances R_1 and R_2 serve as two arms of the bridge and a part of the Wagner ground network. Capacitors C_1 and C_2 assist in the provision of the network and in adjusting the bridge to produce the desired cyclogram, as the osculating trace in Fig. 2 is called. Inductances L_1 and L_2 are coils comprising the other two bridge arms in the vicinity of which are placed the standard sample of the material and the unknown respectively. Capacitor C_3 provides a small coupling between the bridge input and output to produce a shift of phase and an introduction of the third harmonic content to the vertical deflecting circuit referred to above. The various controls are adjusted, with two standard samples in proximity to the test coils L_1 and L_2, so that the desired cyclogram is observed with the two lobes just touching. The ratio of R_1 to R_2

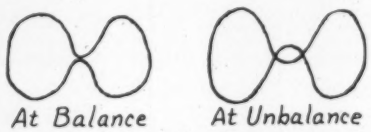


Fig. 2. Cyclogram

is adjusted to give a minimum output from the bridge and once the capacitors are adjusted for the cyclogram they may remain untouched. After initial adjustments have been made, the one standard piece may be removed, and the unknown sample inserted in its stead. If the two lobes remain just touching, the unknown is then determined to be identical to the sample.

An advantage of this apparatus is that it can be used to determine sense. Once it has been determined what effect a concentration or increase in some certain characteristic will have on the lobes; i.e. if they cross over, or if they move apart, the system may be used to classify the fault of the unknown, or to maintain a certain tolerance of the characteristic in production testing. The only requirement of a test of this kind is that the pieces be identical in size and in position with respect to the test coil. The sample need not have a closed magnetic circuit. In some instances it is found that shunting capacitors connected across the test coils will aid in tuning these arms to third harmonic resonance.

The circuit shown was used to test the nickel content of ball roller bearing races which influences their hardness characteristic. The frequency of the oscillator was set at 11,000 cycles. Inductances L_1 and L_2 were each a square coil having 6000 turns of No. 30 wire wound in layers having an outside diameter of 2" and an inside diameter of ¾" and a width of ½". C_1 was a 10-50-$\mu\mu$fd variable capacitor set at approximately 15 $\mu\mu$fds. Capacitor C_2 was variable from 50 to 100 $\mu\mu$fds

and was set at approximately 70$\mu\mu$fds. This slight unbalance was sufficient to produce the desired cyclogram. Resistances R_1 and R_2 consisted of a 50,000-ohm potentiometer set near the center. Capacitor C_3 was variable from 3 to 30 $\mu\mu$fds and was set near 10 $\mu\mu$fds. T was a microphone transformer with two high-impedance isolated secondary windings. Capacitors C_4 and C_5 were 0.0025-μfd fixed capacitors, and C_6 and C_7 were 0.0005-μfd variable capacitors. These capacitors are used to form the resonant circuit comprised by coils L_1 and L_2.

Suitable holders for the sample must be used to assure that they always remain in the same position with respect to the inductance coils.

This system provides an extremely sensitive method of visually observing slight differences between samples caused by variations in permeability, processing methods, or chemical composition. It shows differences in conductivity of equal-size objects made of different metals, and dielectric properties of poor conductors such as plastics and rubbers. In the case of dielectric properties, the standard may be a suitable equivalent electric circuit, or the test coils may be made smaller and shunted by capacitors in which the standard and unknown dielectric are inserted.

The sensitivity and precision of the method are secured through the use of two variables on the balance indicator, those variables being the two osculating lobes.

No obligation of the Allen B. Du Mont Laboratories, Incorporated is expressed or implied in the release of this information.
—W. A. KNOOP, JR.

Electric Thickness Gages Speed Production

By H. P. KUEHNI

General Engineering Lab., Gen. Elec. Co., Schenectady, N. Y.

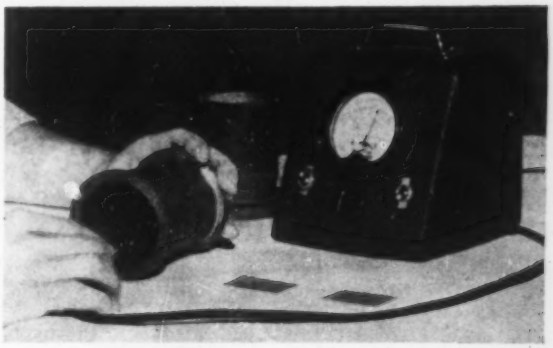
PRECIOUS time and vital materials are being saved in war production by reason of the development years ago of portable electromagnetic gages for speedily and *non-destructively* measuring the thickness of paint on such consumer products as automobile bodies and refrigerator cabinets.* Today, manufacturers of tank and aircraft engine parts are relying on such gages.

For example, steel bearings going into plane and tank engines are lined with lead-bronze, copper, silver or heavy babbitt. Other steel parts often are plated with chrome, nickel or cadmium. The thickness of linings must be accurate to a thousandth of an inch. The thickness of platings must be controlled to even finer tolerances.

Until a few years ago such parts were checked by complex processes which involved selecting a few at random as they came off the production line and cutting them open. Generally the thickness of plating on a part was checked by measurement under a microscope. In another method, wall thickness was measured before and after the lining was removed, the difference between the two measurements representing lining thickness.

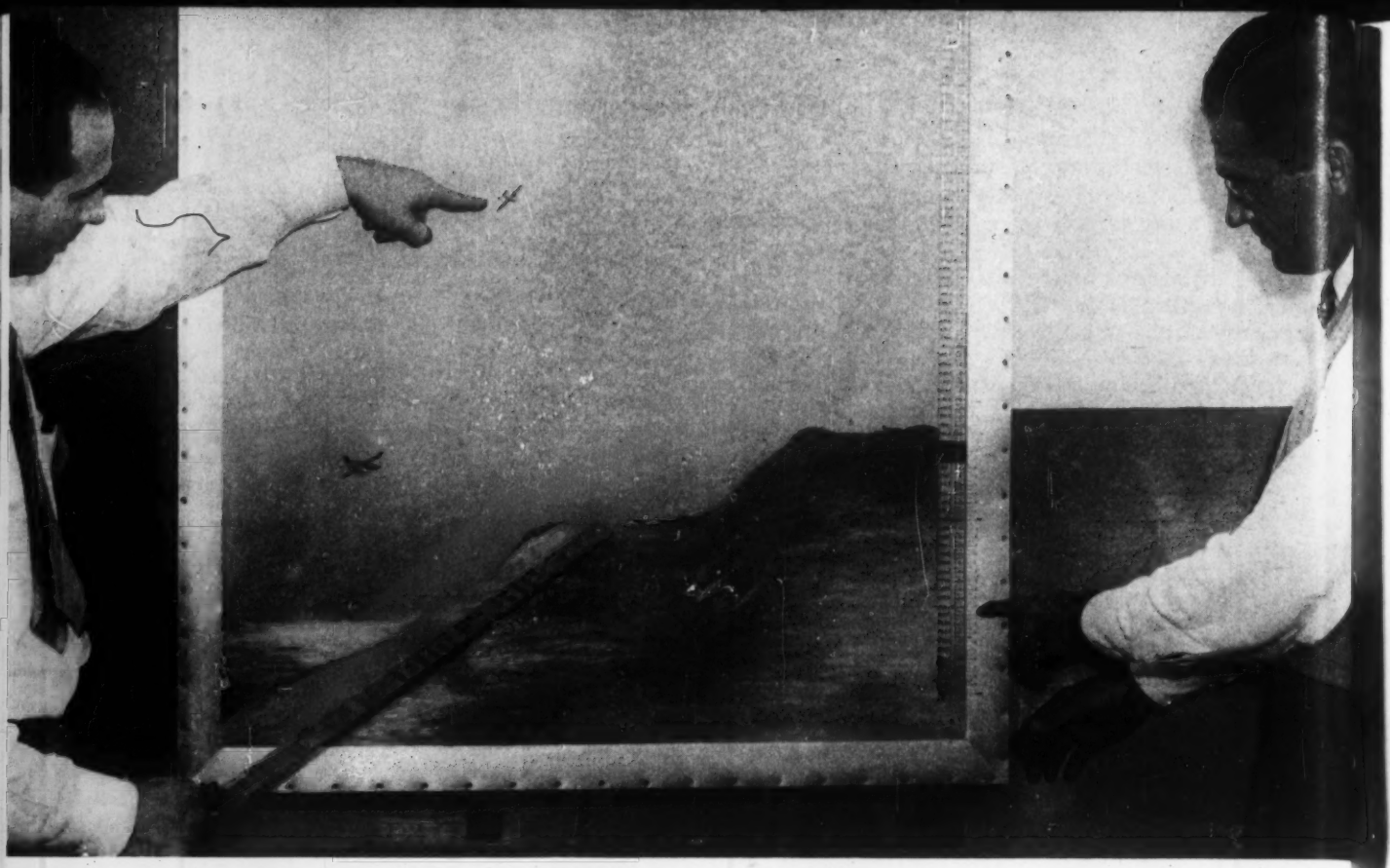
Today, however, this type of portable electromagnetic gage measures the thickness of linings or platings without marring any of the parts, thereby saving time and materials. The main part of the gage is a 7-lb. portable indicating unit with a dial usually marked off in thousandths of an inch (see accompanying photograph). A small cylindrical gage head containing an electromagnet is connected to the indicating unit by a light-weight cable. The instrument is plugged into an ordinary a-c. outlet. When placed against a surface, the gage head can measure the thickness of any nonmagnetic layer up to 0.3″ thick and backed by steel. Its operation is based upon the reluctance of a magnetic circuit comprising a coil in the gage head, the steel backing and the air-gap effect of the nonmagnetic material separating them. This coil is in a bridge circuit. The bridge output voltage, therefore, is a function of the thickness. Therefore, the instrument can indicate the exact thickness on a dial large enough to be read at a glance at production-line speed. Now, *each* bearing is inspected almost the instant it comes off the production line and, when a deviation from standard shows up, the cause of the variation can be spotted and corrected without delay. Thus, quality is rigidly maintained and rejects are minimized.

This particular portable electromagnetic thickness gage was developed originally to measure the thickness of paints. It can also measure the thickness of sheets of glass, mica, etc., placed on steel tables or otherwise backed by steel at the point of measurement.



A different type of electromagnetic gage has been developed for measuring the thickness of nonmagnetic metal sheets and plates such as aluminum, copper, brass and bronze. No steel backing is necessary in the use of this type of gage, which finds applications in checking the wall thickness of magnesium and aluminum alloy castings rolling off assembly lines in mass quantities, utilizes an entirely different principle: its indicating-instrument current is a function of the eddy currents set up in the non-magnetic but conductive material to which the gage head is applied. Of course, the effect on the impedance of the coil in the gage head depends upon the conductivity of the material being gaged, as well as upon its thickness, but with a material of given conductivity the circuit can be calibrated in terms of thickness alone.

*For description, circuit diagram, etc., see *Instruments*, Dec. 1935 page 341. For brief description of newer model see *Instruments*, Oct. 1938, page 259.—EDITOR



Altimeter Demonstration Chart Speeds Training

By SEBIE B. SMITH*
Montgomery, Ala.

PURPOSE of the chart illustrated herewith is to make easy the explanation of the operation, settings, readings, etc. of the Sensitive Altimeter.

This chart consists of a movable screen painted light blue at the top (top not visible in illustration) and dark blue at the bottom, the gradual shade of color representing change in density of the atmosphere. This screen has a Pressure and Altitude Scale (based on the standard atmosphere) printed on it. This entire screen moves up and down relative to a fixed silhouette picture of the sea and two airports at different elevations. There is also a fixed Elevation Scale adjacent to the movable Pressure-Altitude Scale.

The use of this chart is simple. By assuming some barometric pressure at one of the airports, it can clearly be shown what the pressure at sea level (altimeter setting) would be and how the altimeter set to sea level pressure while in the air would read the height above sea level or zero if it landed at sea level, or if set to "Field elevation pressure" how it would read height above the field or zero when landing on the field.

The use of the reference markers is also clearly demonstrated and a direct association of the two systems pointed out. This is easily done because the equivalent altitude scale is opposite the pressure scale and both move together relative to the fixed actual elevation scale.

Therefore it is easy to demonstrate "Pressure-Altitude" setting and how it makes the Altimeter read the same as the field elevation pressure did. The difference between the Pressure-Altitude scale and the fixed elevation scale shows the "Pressure Altitude Variation" either plus or minus. It is easily pointed out how this setting on the reference markers would cause the altimeter to read the height above sea level as did the "Altimeter setting" when the pressure system is used.

The writer has found that the time required to explain the operations of the Altimeter may be cut two-thirds by the use of this chart. Moreover, the students have a much clearer picture of the entire operation than they would otherwise.

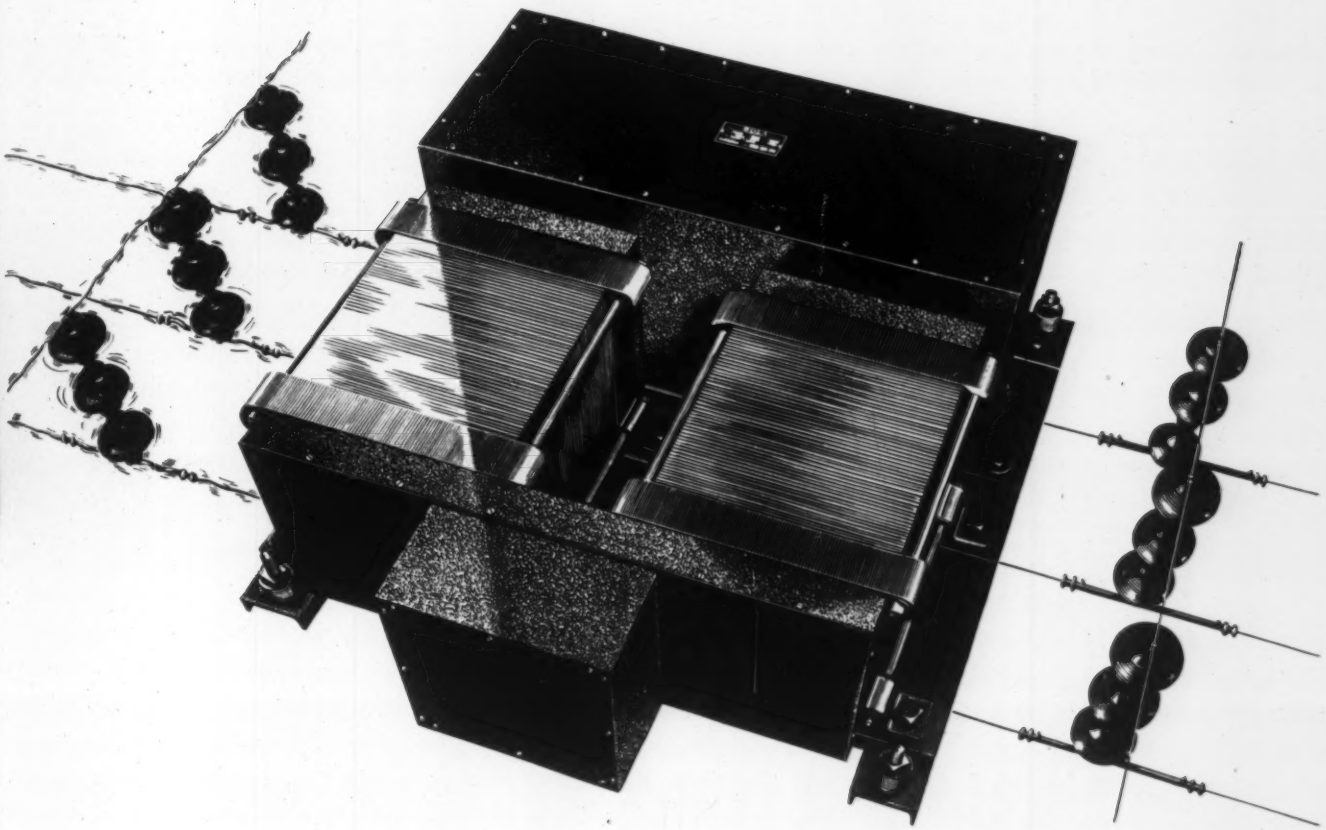
*Formerly Chief Instructor Aircraft Instruments, Embry-Riddle School of Aviation, Miami, Fla.

Salvage Jewels in Old Timepieces

By GLENN R. MANCHESTER
Zion, Ill.

HERE is a suggestion for relieving the shortage of ruby and sapphire bearings. Let your magazine or some government agency contact all jewelry stores, watch-repair shops, etc. In such places there is an almost unlimited supply of old uncalled-for clocks which are out-of-date and no longer worth repairing. Sizes 16 and 18 have many excellent jewels which can serve as bearings for pivots in instruments and fine mechanisms needed by the Army and Navy.

Industry steadies its "nerves"



FACED with production schedules that have no precedent in history, American industry finds the fluctuating voltages of its over-loaded power lines wholly inadequate to meet the "deadly" precision demanded for total war.

Vital "nerve centers" of production lines are geared for precise performance when operated at specific line voltages. Any variation from these rated values, and there are many these days, may well mean lagging production schedules and a noticeable lack of uniformity in products.

Fluctuating line voltages are no problem in plants where Sola "CV's" have taken over. Even though the peaks and valleys of power consumption may cause a voltage variation of as much as 30% — the vital "nerve centers" of their production lines continue to operate smoothly and with unerring precision.

Day and night, without care or supervision, Sola Constant Voltage transformers maintain positive control over electrically operated instruments and machines that are indispensable to the nation's war effort. These transformers are available in standard units with capacities ranging from 15 KVA, which might be used for an entire communications system for instance, to the small 10 VA units for vacuum tubes. Special units can be built to specifications.

Note to Industrial Executives: *The problems solved by Sola "CV" transformers in other plants may have an exact counterpart in yours. Find out. Ask for bulletin CCV-74*

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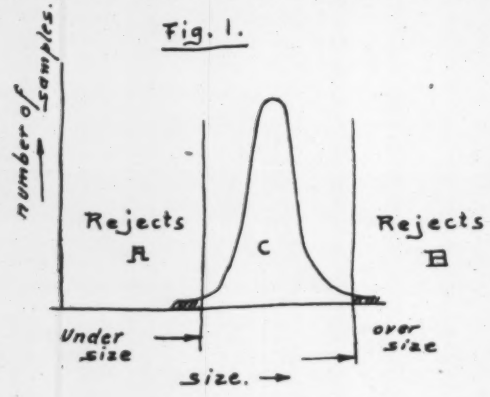
Automatized Statistical Control

By HERBERT ZIEBOLZ
Askania Regulator Co., Chicago, Ill.

ASSUMING a given tolerance in a given production and a uniform production process, a curve showing the distribution of a number of pieces for various diameters will follow a certain pattern, as shown in Fig. 1.

The diagram reveals at once the shortcomings of most current inspection methods. In order to find the relatively small number of rejects, *A* and *B*, all the parts have to be inspected. Too little, if any, attention is usually paid to the field represented by *C*, to the knowledge obtainable from measuring it and the resulting possibilities of eliminating or reducing the number of rejects.



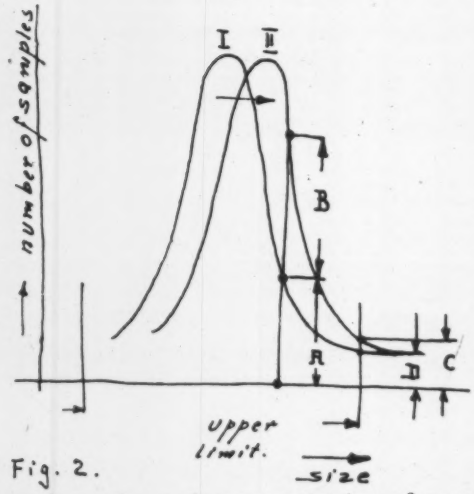


Fig. 2.

There have been improvements, of course. To reduce the amount of inspection work and the number of pieces lost through inspection procedures which necessitated the destruction of the tested pieces, methods have been developed, using a relatively small sample lot from which the percentage of rejects of the whole can be estimated.

But even these methods suffer from the disadvantage of adhering to what might be called the category of "post mortem engineering." The damage is already done by the time it is discovered.

It seems, therefore, to be desirable to approach the problem of production control from a different angle, that of an effort to prevent the occurrence of rejects. Instead of collecting individual data, the aim of this method is to watch the trend of changes in the distribution curve, in order to obtain as early as possible an indication of increases to be expected in the number of rejects.

Fig. 2 illustrates the basic idea. While an increase in the number of rejects from *D* to *C* is difficult to observe unless a great number of pieces is measured, it will be seen that for this minute change in percentage of rejects, a relatively great amount of change occurs in the ordinates of the distribution curves, that is, the ordinate *A increases* by an amount *B*.

As there is a definite relation between the increase of the ordinate *A* and that of the ordinate *C*, it is possible to hold the ordinate *C*, that is, the number of rejects, within sufficiently narrow limits, or to prevent their occurrence altogether by specifying limits for the ordinate *A*.

The method suggested for a better control of the output is to establish the trend of the measured product by observing its shifting distribution curve. To this end it is necessary to produce a

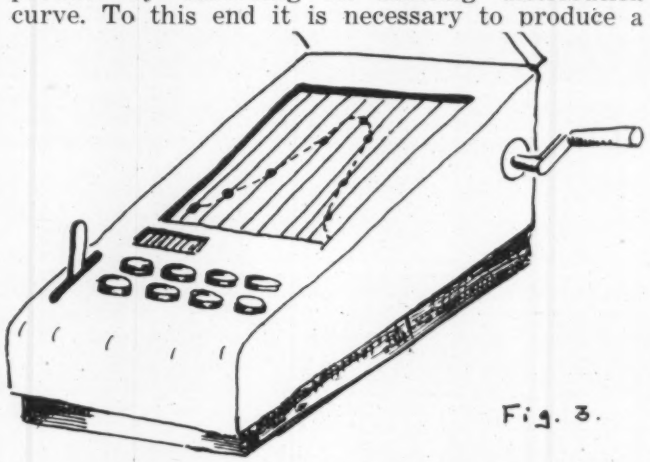
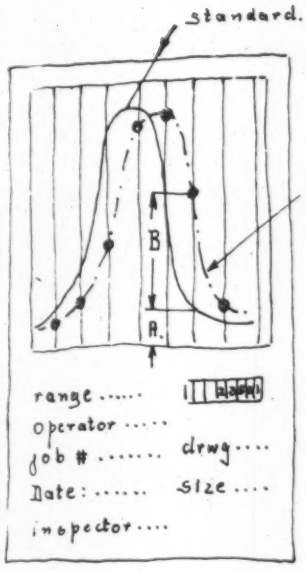


Fig. 3.

graph of the distribution of the samples and to establish, either continuously or for a given lot, the magnitude of the ordinate *A*. This method enables us to prevent the increase in number of rejects, or their appearance altogether, and we herewith enter the field which may be termed "preventive engineering." The mechanism used for this purpose is called a "Trend Analyzer."

The Trend Analyzer mechanically produces the necessary graphs showing the distribution curves of the tested lot. In its simplest form it consists of a number of spindles, carrying indices, the position of which shows the number of samples falling into a given range. It can be operated by a keyboard, either mechanically or electrically (Figs. 3 and 5). The position of the indices represents the distribution of sizes typical for the particular production method.

By comparing the ordinate *A* with $(A + B)$ for a given number of samples, an indication of changes in the output can be obtained and changes in the number of rejects can be predicted. To make this comparison easy, records can be made by printing the position of the indices, by simply pressing a carbon copy and a recording form against them and comparing their positions with previous or normal records (Figs. 3 and 4).



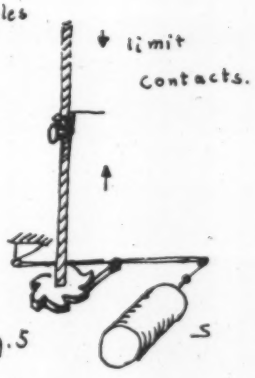


Fig. 5

Another possibility is to cover the face of the Trend Analyzer with a transparent sheet showing the typical or desired distribution curve.

If only one product or only one typical distribution curve is to be analyzed, it is possible to reduce the number of indices to one, in this case only the one showing the change from A to $(A + B)$. The indicators can be automatically operated by automatic gages and can ring a warning signal or shut down a process when the ordinate A gets out of range (Fig. 5).

Fully automatic devices can be built which give a continuous record of a consecutive but definite number of samples. Such a device gives the distribution curve of the last and first number of samples. The Trend Analyzer can also be used with punch card records, as these can be made to energize solenoids representing various ranges.

It is believed that this method would be particularly useful in the field of training of operators.

Whether the product is a piston of given dimensions or represents the marksmanship in hitting a target, a record of the distribution curve obtained by such a device can be used for analysis of the causes of deviation from a given standard. Furthermore, the record will also show the changes resulting from different manufacturing methods, machines, or the progress of individual operators.

The method eliminates the waste of hit-and-miss efforts in aiming at certain standards, and on the other hand also a lot of laborious statistical calculating. It places at the disposal of the supervisor information which previously could be supplied by an expert statistician only.

Fast-acting Sensitive Draft Gage

By L. W. WINBOLT

International Harvester Co., Tractor Works, Chicago, Ill.

WHENEVER manometers measuring a few inches of water are needed in our laboratory, we have found that the addition of a little fluorescein dye plus a drop or two of Aerosol (the wetting agent used by photographers) improves the instrument fluid tremendously. In fact, we have built several simple water-filled draft gages which can be read to 0.005 inch.

Water used in an inclined draft gage is itself much faster-acting than the conventional oily draft gage fluid. When Aerosol is added, a much sharper meniscus can be obtained. The resulting liquid with the dye added makes a cheap, fast-acting, accurate indicating medium. Evaporation will take place, but this is not objectionable in most cases. More liquid can always be added when necessary.

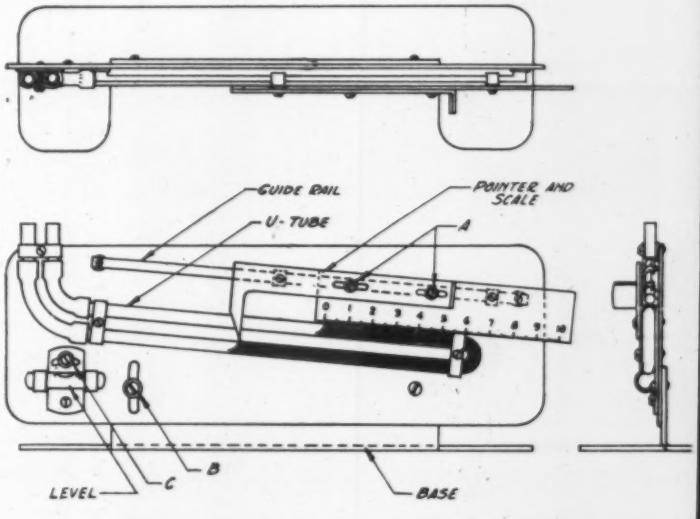
The gage shown here was constructed out of parts on hand. A U-tube of ordinary 6-mm. glass tubing was mounted on a metal back inclined at about five degrees off the horizontal. A scale marked in inches and tenths was used, with the intention of measuring one inch of water maximum draft. The tenth division marks would thus become hundredths of an inch of water. The sensitive level was also home-made, of ordinary glass tubing bent to an arc of about one foot radius, sealed with De Khotinsky cement. Stoddard Solvent was used, and a very active bubble resulted.

The instrument must first be calibrated against a standard by making adjustments at points A and B and shifting the scale so that the pointer remains opposite the meniscus on the lower leg, for both the zero and one-inch points on the upper leg. This is not hard to do by good old cut and try. An accurate one-inch standard water manometer can be made by using a vertical U-tube and the water-Aerosol solution. It will be used only for the one-inch point, and a magnifying glass is perfectly in order. A small mercury U-tube and a few short lengths of rubber tubing can produce the exact pressure differential needed for calibration.

If desired, the scale can be self-reading, that is, it can measure one leg of the U-tube only. The pointer would then be unnecessary, the speed of reading increased, and the accuracy halved.

After calibrating, the level bubble is centered by means of screw C, and set permanently.

The speed and accuracy of this instrument may surprise you.



A WORD ABOUT DELIVERIES

Naturally deliveries are subject to necessary priority regulations. We urge prompt filing of orders for delivery as may be consistent with America's War effort.

Combat Line

EASURING INSTRUMENTS

in Review

A Glimpse into the Future

Out of the needs of war; out of tripled production lines and twenty-four hour days; out of the drive for "better performance under spectacular stress and vibration," comes Triplett precision instruments in volumes impossible by now outmoded peacetime methods. Today our country's needs come first—Tomorrow when America again takes up peacetime pursuits, the values of these experiences will be apparent, in savings, in performance, in technical superiority beyond the concepts of yesterday.

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TRIPLETT

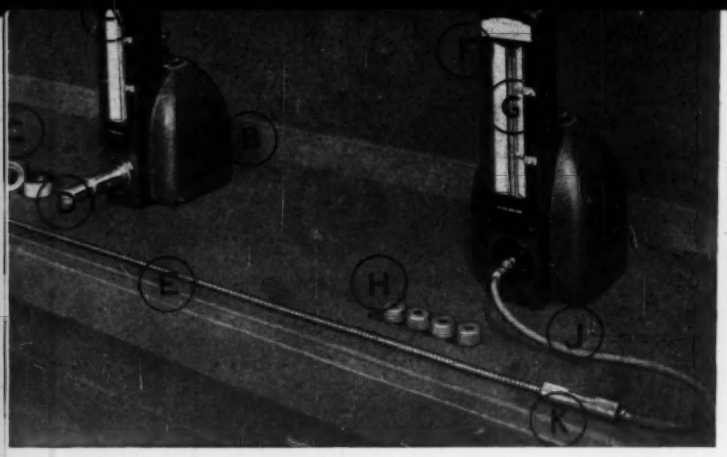

Fig. 1. Principal elements of "Precisionaire" gages "Model A" (right) and "Model B" (left). A—indicating instrument. B—air supply. C and H—master setting rings, maximum and minimum. D—gaging spindle. E—graduated extension. F—Transparent indicator tube. G—adjustable marker. J—flexible tubing. K—handle.

Fig. 2. Inspecting barrels with the "Precisionaire."

Speedy Pneumatic Method of Bore Gaging

By ALBERT POLK

Vice President in Charge of Engineering, The Sheffield Corp., Dayton, Ohio

EXCEPTIONAL progress has been made in war gaging equipment and practices. During the last previous conflict, precision inspection relied almost exclusively on the fixed-size gage. Inspection was a serious bottleneck.

The gaging industry had made significant improvement during the decade just preceding the outbreak of this war. Tolerances had become progressively smaller, the comparator type gage had come into general use, and with it selective assembly. A good start had been made also in the fields of multiple gaging, air gaging, automatic gaging, and automatic machine control. The stress of actual war speeded progress in all these phases of dimensional control, especially in the field of air gaging. The new system of air gaging discussed in this article is revolutionizing the process of gun barrel inspection and, in fact, the inspection of all types of long bores, deep blind holes, stepped holes, bores too small to be checked otherwise, and highly-finished bores vulnerable to scratching.

There are many ways of checking an inside diameter accurately when the ratio of bore length to bore diameter is small. As that ratio is increased beyond unity, the problem becomes more and more difficult and equipment considerably more limited. When this ratio is as great as it is with a gun barrel, for instance, none of the usual internal gages is adequate.

Prior to the development of the type of gage known as the "Precisionaire," gun barrel inspection was a long tedious operation that required a highly skillful operator. Now, by means of this new method, a barrel is checked to an accuracy of 0.0001" in no more time than it takes to run a cleaning rod through that barrel. Moreover, it requires little skill on the part of the inspector, thereby saving time in training for war work.

OPERATING PRINCIPLE

Compressed air from the regular plant supply enters the gage through an automatic compensating pressure regulator, passes through a vertical transparent indicator tube and out through the orifice in the gaging spindle. This constitutes the air column of the Precisionaire.

Unlike the conventional air gage, the Precisionaire is actuated by the *velocity of air at constant pressure*. For this reason, there can be no time lag in gage action and, consequently, it makes no difference how far it is between the gaging spindle and the indicating instrument: the indicator responds instantly. (This may not be true in the case of Sheffield's older and other pressure type gages, in the use of which it is necessary to wait for the pressure in the air tube between indicator and part to equalize: the longer that distance, the longer it takes.) In the Precisionaire an indicator float in the transparent tube is free to move up and down in immediate response to the changes in velocity in the air passing through the tube and around the float. The greater this velocity, the higher the float rises in the tube.

Any practical degree of magnification is available by making suitable changes in the assembly of the indicating instrument.

The volume and velocity of air flowing at any given instant during the gaging operation depends only on the clearance between the gaging spindle and the sides of the bore being gaged. The greater this clearance, the higher the velocity of air that passes between the sides of the spindle and the internal surface of the bore.

METHOD OF SET-UP

With air pressure on, a minimum master ring is slipped over the gaging spindle and air pressure adjusted so that the indicator float will rise to a point in the central zone of the tube. One of the adjustable markers is then set opposite the float's position. Substituting the maximum master ring sends the indicator float higher in the tube. The second marker is used to mark this second float position. The length of tube between the two markers now represents the difference in diameter

only ONE operator

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A new precision "fixed-weight" instrument for calibrating Fluted Guide Flow Indicators, Rotameters and other rate-of-flow indicators for motor fuels.

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MICROMETER CONTROL VALVES FOR REGULATING FLOW.

REMOVABLE PANEL FOR MOUNTING FLOW INDICATORS.

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SIZE: 76" x 48" x 30".

WEIGHT: APPROXIMATELY 1000 LBS.

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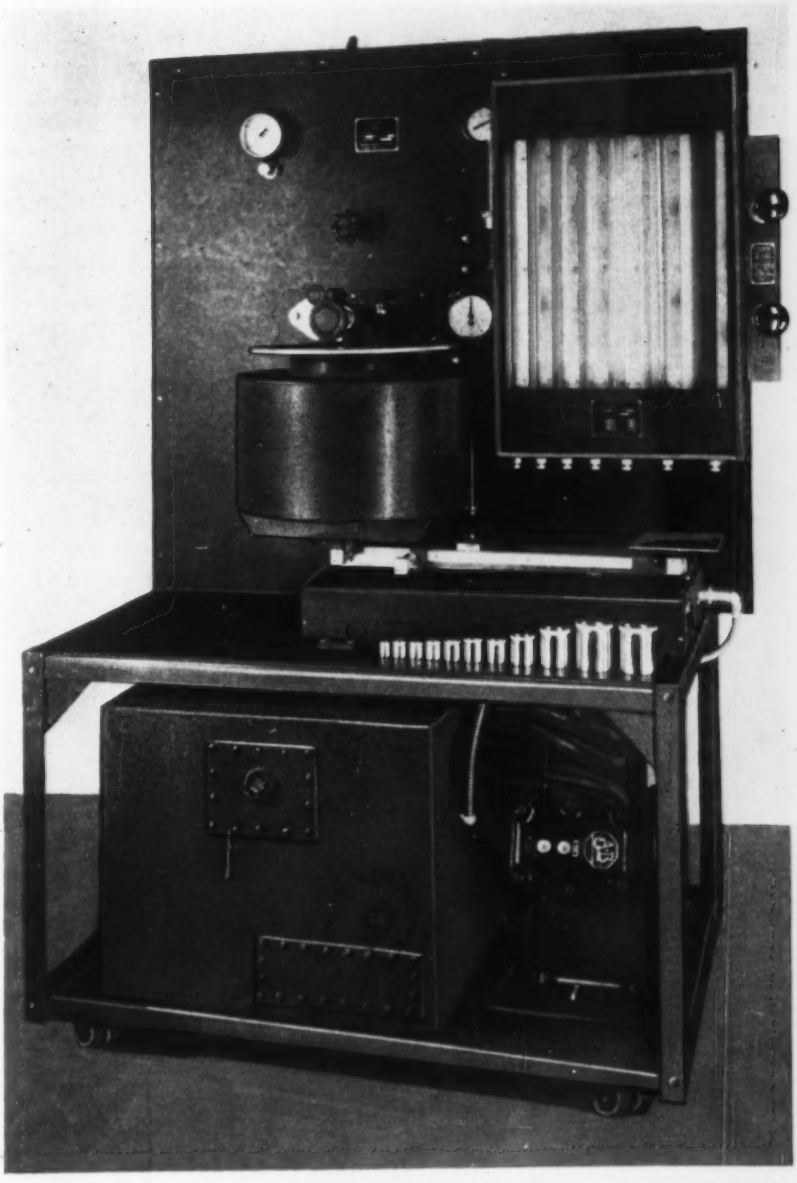

The Cox Type VI Calibrating Stand with the new automatic precision balance is illustrated. A Type VII Fluted Guide Flow Indicator is mounted ready for calibration.

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between the maximum and minimum master rings —or the tolerance of the work to be gaged.

SPINDLE CONSTRUCTION

The spindle takes one of several forms, depending on the nature of the operation contemplated. Essentially, it is a cylindrical plug having a central air channel which terminates in one or more jets in the side of the spindle just back of its forward end. Where it is desired to check average diameter instead of the actual diameter at a given point, the air jets in the gaging spindle terminate in annular grooves cut entirely around the spindle head. When actual diameter, out-of-round, taper or bell mouth is to be checked, the two diametrically opposite jets open directly onto the spindle surface.

The gaging spindle used to check the rifling in a gun barrel is similar, except that its jets terminate in bosses raised beyond the regular surface of the spindle cylinder. These bosses extend into the rifling grooves. The rifling spindle is inserted into the gun bore with these raised bosses in register with two opposite grooves. It is passed through the bore following these grooves, repeating the process until each pair of grooves has been checked.

INSPECTION OPERATION

The casting-rod flexibility of the extension eliminates any error which might otherwise result from a misalignment of the spindle in its passage through the bore. This flexible extension causes the spindle to center itself.

The inspector passes the gaging spindle through the bore in one continuous pass, watching the indicator float as he does so. Any variation in bore diameter instantly causes the indicator float to change its position. When checking for an out-of-round condition, the inspector turns the spindle or part with relation to the other.

If the float remains between the adjustable markers on the scale, the barrel is within tolerance and acceptable. If it passes either of the markers, it is either undersize or oversize at that particular point and must be rejected.

After the rifling operation, a second gaging spindle is used to check the diameter of the rifling grooves, as previously indicated.

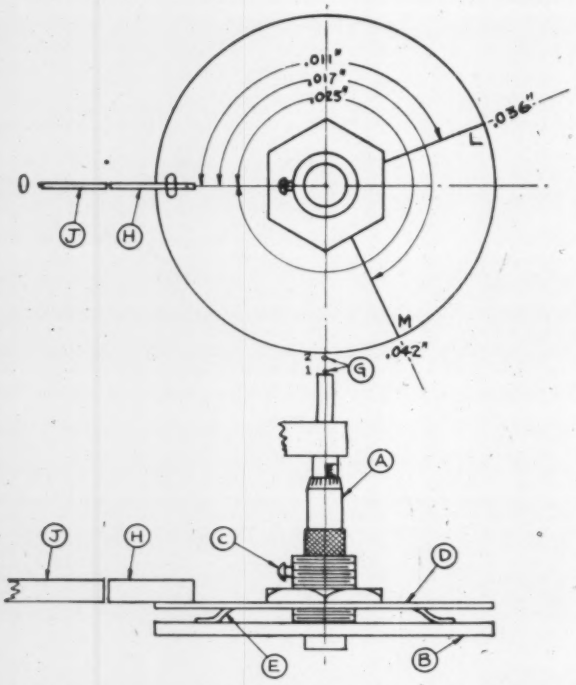
This type of inspection is applicable to any rifle or gun barrel the tolerance of which does not exceed 0.005″. The same instrument, with change in spindle, may be used on any number of bore diameters.

Limit Dial for Micrometer Speeds Inspection

By F. L. FAHY

Manning, Maxwell & Moore, Inc., Bridgeport, Conn.

THE sketch herewith illustrates an attachment for a standard micrometer head which eliminates any reading of the micrometer when gaging



is to be done within specified limits. We have used this device successfully in measuring the tip travel of Bourdon tubes. The requirements in this case were 0.036″ to 0.042″ travel for 50 lbs./in.². The sketch illustrates the sector used for this purpose.

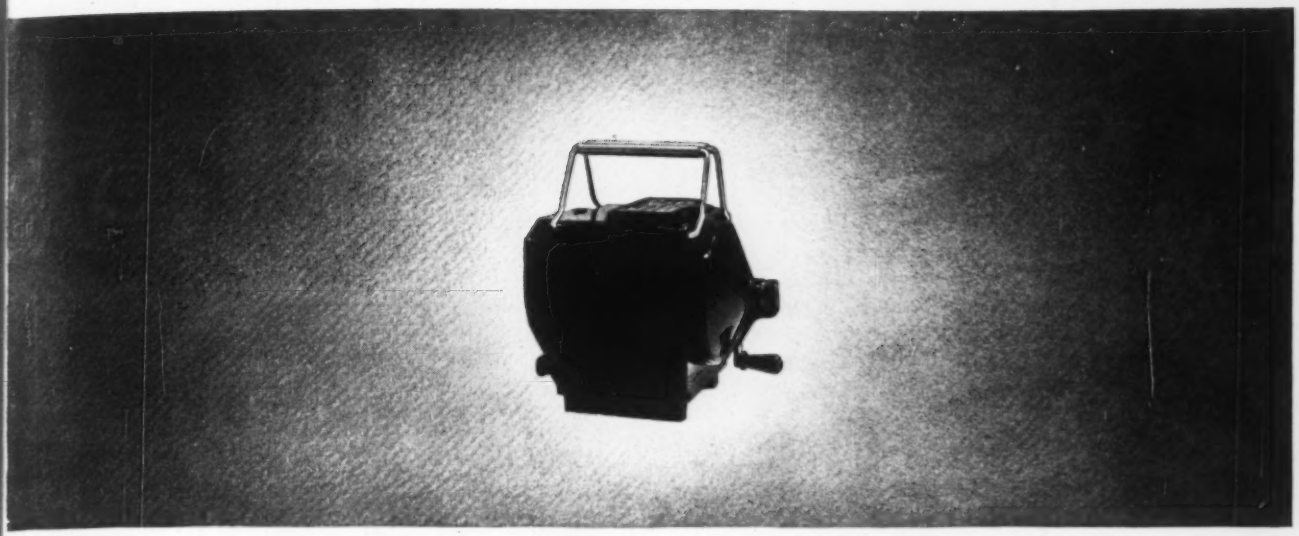
A is a conventional micrometer head. *B* is a disk fastened to the micrometer head by means of the set screw *C*. *D* is the measuring sector superimposed on disk *B* and frictionally engaged with disk *B* as by means of ears *E*. Sector *D* carries zeroing arm *H* and is cut out in accordance with the tolerances specified. *J* is the fixed reference arm.

In operation the micrometer barrel is brought up to contact tip *G* at position 1. A low-voltage circuit is closed and a signal lamp is lit. Disk *B* is now held to prevent its rotation and disk *D* rotated until zeroing arm *H* lines up with the zero reference arm *J*. The known pressure (50 lbs./in.²) is now applied to the Bourdon tube, the tip *G* being caused to occupy position 2. Disk *B*, *carrying disk D*, is revolved, bringing the barrel of the micrometer into contact with the tip.

One full turn of the micrometer barrel (0.025″) is made, after which the operator has but to observe that the circuit is closed when any portion of the minor arc *LM* is opposite fixed arm *J*.

For measurements requiring more than two or three turns, it may be desirable to incorporate some type of indicator for counting the number of revolutions of the barrel. The sector can be cut to accommodate tolerances totaling 0.020″ or so and can be cut for each individual job or made adjustable. When made adjustable, it is desirable to index disk *B* to facilitate setting.

As can be seen, the device obviates the need for reading, writing down and subtracting two micrometer readings; it eliminates the resultant possibility of error; it is readily used by operators who have not had to be educated in reading micrometers.



To Our Customers and Friends:

"Megger" Testers are, as you can well imagine, in unusually heavy demand during these strenuous days. Now, if ever, electrical equipment *must not fail*.

Although the demand has been for a quantity of instruments many times larger than our normal pre-war volume, we have so far been able to fill most high priority orders on schedule. Ours is the unique responsibility of supplying America's electrical men who must maintain electrical equipment on land, on the seas and in the air—with a testing device that is a vital necessity.

To this end we are now concentrating on the building of the more generally used types of "Megger" instruments in our Philadelphia factory We have complete manufacturing facilities, a loyal group of skilled men and women, and above all the *determination* to see that you get all the "Megger" Testers you need—at the earliest possible date.

JAMES G. BIDDLE CO.
January, 1943

P.S.—*We urge you to inform us as soon as possible of your requirements for "Megger" instruments, so that we can plan our production to meet your needs.*

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pH Meter Speeds Repair of Connecting Rods

By J. M. PLUMMER
Leeds & Northrup Co., Philadelphia, Pa.

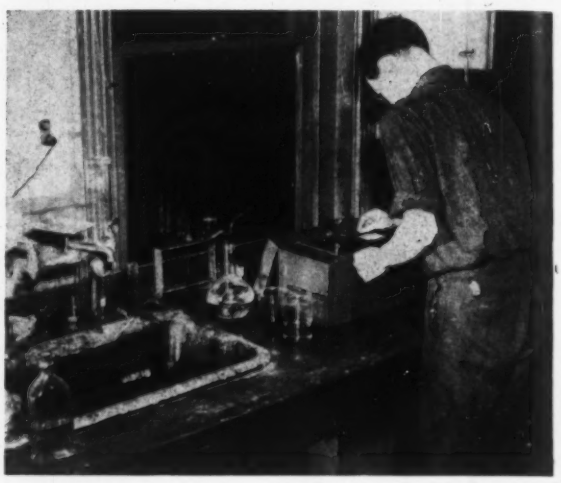
WORN connecting rods of marine diesel and gasoline engines are salvaged by the Philadelphia Rust Proof Co., Philadelphia, Pa., by simply plating enough iron onto their worn surfaces so that machinists can restore original dimensions.

Like many successful processes, however, this plating operation reached success only after a stubborn "bug" had been located and exterminated. In this case, the bug was that the iron deposit tended to be either too brittle or too soft.

Rust Proof's technicians knew that the pH of the plating bath was largely responsible. Their first step, therefore, in correcting the situation, was to improvise a pH meter and run some tests. Results were encouraging, but they showed that the tolerance band for pH was only 0.2 pH wide, and the technicians didn't believe pH could be so highly critical as that figure would indicate. Furthermore, even when they maintained pH within the narrow band by adding as much as a gallon per hour of muriatic acid, the plating results weren't entirely satisfactory.

However, since the checks made with their homemade pH meter had done some good, it was felt that perhaps the trouble lay simply in the known inaccuracy of that instrument. It was decided, therefore, to replace it with a glass-electrode pH Indicator, made by Leeds & Northrup.

With this instrument, the bug-hunt came to a swift and successful close. It showed that the true band of H-ion concentration, for the particular job in hand was 1.5 pH, instead of only 0.2 pH; that band is easy to hold, and results are described as "excellent." Furthermore, acid consumption dropped from a gallon an hour to a pint, and the glass bags formerly used to hold anode iron are no longer needed. Resulting savings in material, transportation, storage and handling would easily justify the use of the Indicator, but the improvement in plating and the saving in time are the vital features in the winter of 1942-3.

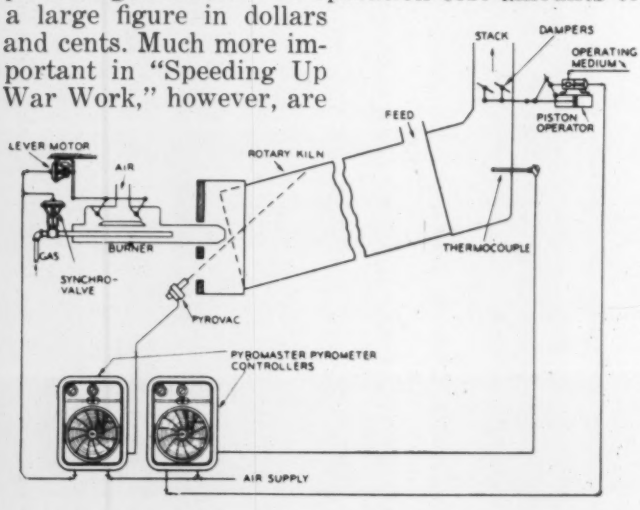


Chemists at Philadelphia Rust Proof Co. making routine checks of pH of iron-plating bath, as a means of holding deposited iron at proper hardness and consistency.

Automatized Kiln Saves Time and Materials

By A. A. BLACKMAN
District Manager, St. Louis Office, The Bristol Co.

AFTER several years of hand operation, air-operated round-chart recording pyrometer controllers were installed on a rotary lime kiln. The present input of this kiln is 500 to 700 tons of wet lime a day, so it can be seen that even a small-percentage reduction in operation cost amounts to a large figure in dollars and cents. Much more important in "Speeding Up War Work," however, are other results of the installation of automatic control, among them the following:



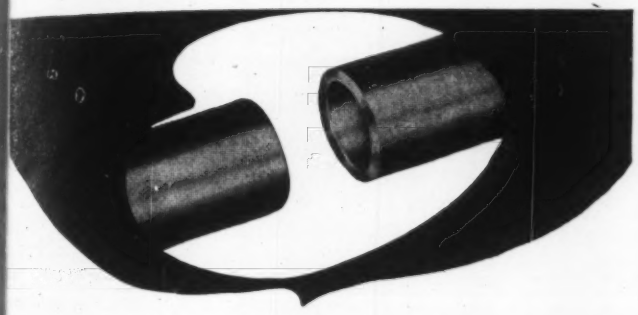
(1) Kiln now operates 90 to 95% of the time instead of 50% maximum obtainable with hand control. This large increase in operating time is due to the elimination of mud-rings and also reduction in shut-downs for re-bricking and other repairs.

(2) There is a considerable reduction in fuel consumption per ton, lessening the demands upon other industries.

(3) A more uniform product results and therefore savings of time, labor and materials are possible on subsequent processing.

(4) Due to even temperature gradient in kiln, stresses causing expensive repairs are greatly reduced, and lining life has been greatly increased.

The diagram shows the "Pyrovac" radiation type pyrometer, which controls the fuel, and the thermocouple type pyrometer which controls the flow of heat through the kiln to the feed end and maintains the feed end temperature constant by adjusting the stack dampers.



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MARKS *the* SPOT

Where the pointers cross in the gage illustrated the percentage of *air excess* is indicated. Scales can be furnished that will show in similar manner the exact ratio existing between the flow of gas and the flow of oil or other measurable fluid or

HAYS VISIO-RATIO GAGE

between any two of the following functions: pressure, draft, suction, temperature (up to 1000°F.) speed in R.P.M. or inches per minute, position, level, etc. Has many uses in steel mills, gas producing plants, heat generating plants, CO_2 generating plants, sewage plants, chemical plants, kilns, air-conditioning and others. Write us and learn how this newest Hays gage may be applied to your own flow measurement problems.

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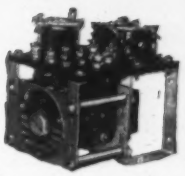

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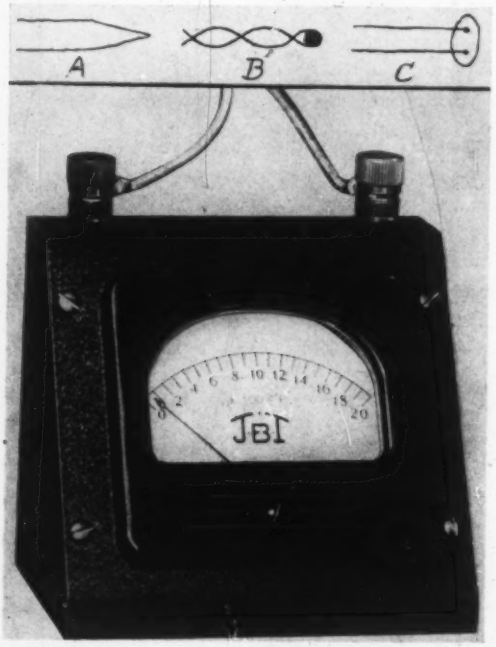
LEADERSHIP THROUGH APPLIED RESEARCH

Infra-red Tunnel Temperature Measurements

By DONALD E. ANDERSEN
Development Engineer, J-B-T Instruments, Inc.,
New Haven, Conn.

IN drying finished parts in infra-red tunnels, ovens or banks, it is important that the temperature be read at all times to prevent discoloration, scorching or insufficient drying. A great deal of experimental time is saved and the observations become a relatively simple matter when done with a traveling thermocouple and the indicator illustrated. A 40-ft. length of duplex flexible thermocouple wire is attached to the binding posts of the stand. The thermocouple then can be sent through with the work in process and a temperature at any point can be more accurately controlled. The instrument, as mounted in the stand shown, can be placed anywhere near the tunnel. Automatic room temperature compensation is included, to enable the operator to read work temperatures without correction or adjustment.



Several types of thermocouple tips can be used, three being roughly sketched. Type *A* is sharply pointed with about 0.010″ tip, and can easily be pushed into soft material. Type *B* has a round tip for insertion in crevices. Type *C* consists of a thermocouple silver-soldered to a small copper disk. This disk can be painted exactly as the work is painted, and sent along to dry in the tunnel with the other work, giving a closer indication of the temperature of the paint.

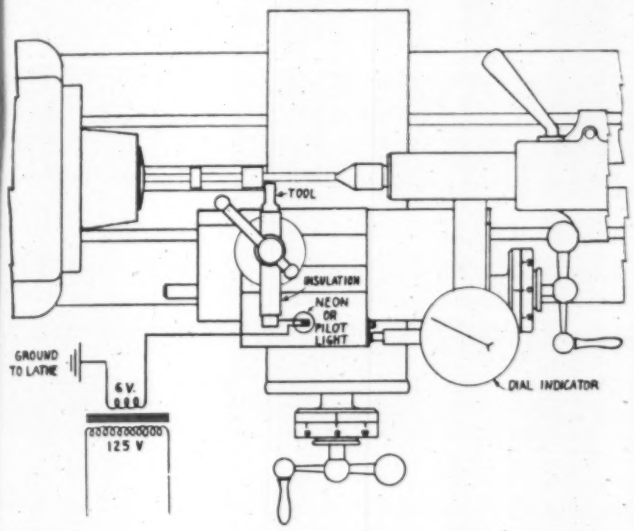
After studying a few test runs to determine the rate of travel and the number of lamps to use along the line, is becomes possible to improve the quality of the finish, greatly reduce the percent of rejections, and otherwise save man-hours in the departments involved.

Pilot Light for Tool Setting

By C. P. FISHER, Jr.
General Electric Co., Schenectady, N. Y.

PRECISION lathe work requiring an accuracy of five hundred-thousandths of an inch is speeded by a pilot-light indicating method developed by M. M. Cunningham, a foreman at General Electric's Schenectady Works. His method replaces the old practice of using a magnifying glass to see when the tool makes contact with the surface to be cut. In Cunningham's method, electrical contact between tool and work is used to close a light circuit, telling the operator exactly when to set the dial indicator at zero, thus eliminating the human element and establishing a sure basis for making a cut within the required accuracy of 0.00005".

The tool is speedily brought up to the surface to be cut until it is just about to make contact, then it is brought up slowly until the pilot light flickers, then *very* slowly until the light is steady. At this



point the dial indicator is set at zero. A cut of any desired depth can then be made with the accuracy of the cut dependent only on the accuracy of the dial indicator and of its reading.

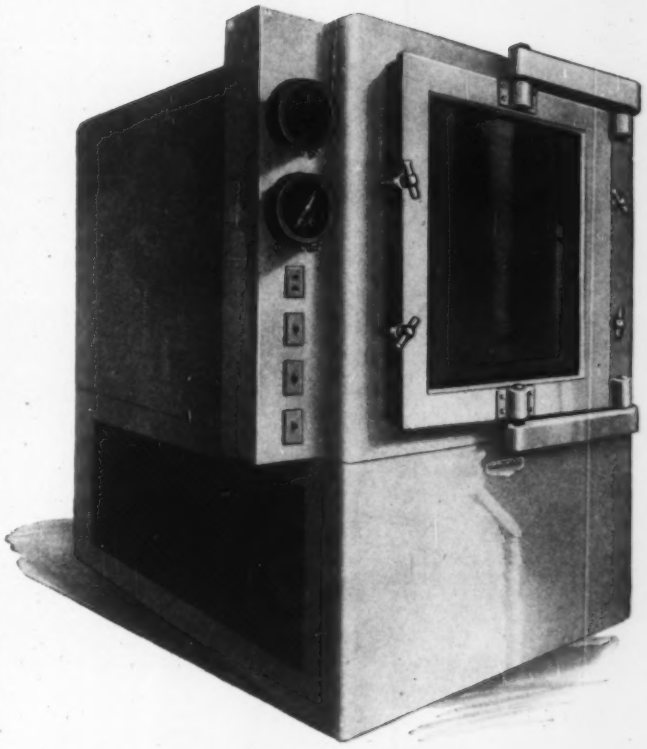
Either an incandescent or a neon indicating lamp can be used for the pilot light. A small transformer is used to reduce the standard 110-volt circuit to 6 volts for the detecting circuit. One line from the transformer is connected to the bed of the lathe; the other line to the screw shell of the light socket. The center contact of the light socket is connected to a metal strip which makes contact with the lathe tool, being set against the tool when it is locked in the tool post.

The tool is insulated from the tool post with a piece of varnished cambric or light cardboard.

This pilot-light indicating method can also be used where the work is stationary, such as on milling machines, by insulating the work from the machine and connecting the center contact of the light socket to the work.

[ED. NOTE—All right, all right, you old-timers! I know what you're thinking, because I was making precision instruments more than thirty years ago, when reliable flash-light bulbs became available, requiring only six volts or three volts—some models only 1.5 volts—so that it seemed easy to find a material for insulating the tool *without sacrifice of rigidity*. Boyoboy, they sure make wonderful cambrics and cardboards nowadays!—M. F. BEHAR.]

KOLD-HOLD



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"As Standard as Sterling"

How to
FIGHT "BULLS"
that come from
careless counting
Where production relies on miscounts and guesswork . . . "bulls" are bound to charge in and rip up production schedules . . . until mistakes are made impossible by up-to-the-minute operating records. So fit your war-production machines and processes with Veeder-Root Counting Devices . . . avoid delays, shortages and over-runs . . . improve interdepartmental co-ordination toward final assembly. See how you can make your work count to the utmost . . . by counting on Veeder-Root. Write.
VEEDER-ROOT
INCORPORATED
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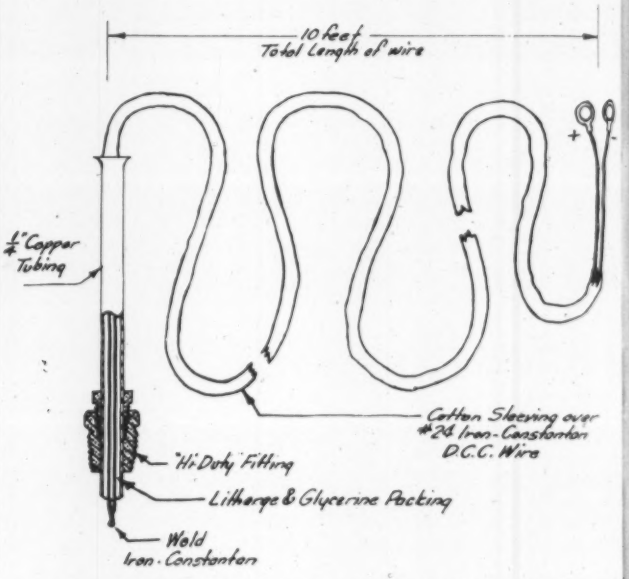
Standard Thermocouple

By L. W. WINBOLT
Instrument Div., Gas Power Eng'g Dep't,
Int'l Harvester Co., Chicago, Ill.

FOR several years we have been using in our laboratory a thermocouple which is comparatively cheap to make and very serviceable for a wide variety of test work. We use standard thermocouple wire, mostly No. 24 S.C.C. enamel or D.C.C., iron and constantan. Cotton sleeving, as shown in the accompanying sketch, holds the wires together and facilitates handling. At the couple end the sleeving is imbedded into the flared end of a short length of ¼" copper tubing. The wire and sleeving are sealed into the tubing by pouring or forcing into the flared end a thick liquid mixture of litharge and glycerine and allowing the mixture to set hard.



A standard fitting with ⅛" pipe thread is used, after drilling clear through it with a 17/64" drill so the couple can be set in position conveniently. Steel tubing can be used instead of copper, but the whole should then be coated with a good enamel to retard rusting. In any event, enamel coating of the welded end of the couple will lengthen its life for most jobs, and detracts in no appreciable way from its speed or accuracy.

New Type of Pressure Gage Triples Testing Speed

By FREDERIC I. LACKENS
The Hays Corp., Michigan City, Indiana

THIS is the story of an instrument that not only saves a lot of valuable time in the production of gyro-pilots for the Army and Navy Air Forces, but permits the work to be done with greater accuracy and by unskilled hands. The customary method of testing these automatic devices had been to employ a U-tube manometer, which required two separate readings for each test to determine the differential pressure and which required that the operator be trained in making accurate meniscus readings of the fluid in the U-tube.

Through the use of a dry-type measuring unit employing a slack diaphragm, the differential pres-

sure is accurately measured by a single unit and the correct reading given on a large scale (11" × 6") easily read by the operator, with the result that it has been possible to more than triple the readings per hour.

The gages have now been in use over six months, eight hours a day, seven days a week, making an average of 24 oscillations each over ⅔ of the scale every five minutes, or 288 tests per hour per gage.

The actuating mechanism is a differential type slack-diaphragm unit, the same as used in Hays pointer gages for boiler rooms, with the exception that in this case the diaphragm is of synthetic impregnated material, with a flexing resistance ten times that of rubber.

The gages are inclined at an angle of 20° from vertical for ease of reading. The scale has a range of —20 to 0 to +20 inches of water, which is more than ample for the purpose for which it is employed. In addition to the fact that instantaneous readings are possible, greatly speeding up the tests, *man*-power is relieved because the twenty-five gages now in operation are "manned" by women. Other advantages of the dry type measuring element: there is no danger of spilling liquid and no danger of freezing or evaporating; it is not necessary to trap the gage; the gage is easily set to zero without opening the case.

The gage is known as the Hays "Series FOT."

Worker-chosen Classical and Soft Music Improves Output

By Miss ADA HONINGFORD
The Palmer Company, Cincinnati, Ohio

IN our business (manufacture of thermometers) speed is not so essential as accuracy. When we tried to rush the work through, the workmen would get jittery. So after discussing the problem with the employees, we installed a music box which plays, at certain intervals during the day, classical and soft music which is brought to all parts of the shop by means of loudspeakers. The volume of each loudspeaker is so regulated that the music comes through the departments where machinery makes a good bit of noise and is soft enough in other departments.

There has been a marvelous improvement in the feelings and work produced by our employees. They report that the music soothes their nerves and permits them to work comfortably and thus produce not only good and accurate thermometers but with more speed.

The music is not played all day but at intervals when they feel it will do the most good. The employees select their records and we pay for them and add them to the collection.

Of course, other ideas are being applied here, such as studying various operations and making special tools to produce the work more speedily. This happens every day and we find that our production has been stepped up by labor-saving devices rather than increased number of workmen because in our business, we must train every person we hire and they must have qualifications that we do not seem to find in the average applicant.

and for FREEDOM
from Solder Failure

Photo Courtesy Kellogg Switchboard & Supply Co.

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• SOLDER today is a vital war material! Wherever it is used in production of fighting machines and the equipment that goes into them—in safeguarding heavy-duty or delicate electrical circuits; in general metal-joining applications; in *any* of its many important uses—it *must hold tight!*

• Kester Cored Solders measure up to the most exacting war jobs. They expedite production, *safely*—flux and solder, both in proper kind and amount, are applied in one simple operation. The high effectiveness of Kester fluxes and superior quality of Kester alloys insure permanent results, an unequalled resistance to bending, vibration, shock, contraction and expansion.

• Kester Rosin-Core Solder, for electrical applications, contains a special, patented plastic rosin flux that won't injure insulating material or cause corrosion. Kester Acid-Core Solder, for general use, makes a tight, clean, permanent union.

• All Kester Cored Solders are available in a wide range of core and strand sizes, meeting every production requirement. Consult Kester engineers freely, without obligation, on any soldering problem.

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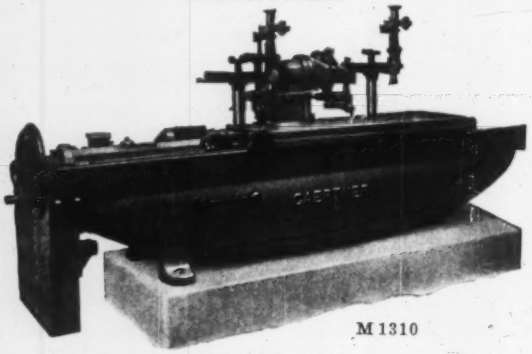

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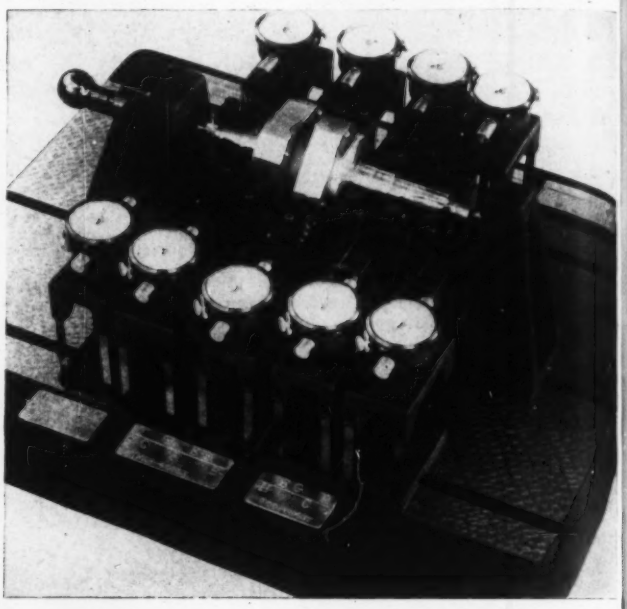
One Multiple Gage Practically Equals 63 Fixed Gages

By I. A. HUNT
Federal Products Corp., Providence, R. I.

ILLUSTRATED herewith is a production gage designed for the multiple inspection of diameters simultaneously. It is designed to inspect seven different quantity-produced rotors, each of these seven rotors having a different set of diameters. Nine dimensions of each rotor are inspected simultaneously. Each diameter is indicated in tenths of thousandths of an inch.

The gage is so designed that it can be reset for the other six rotors; hence one gage is capable of



inspecting sixty-three different diameters. Imagine the saving of time required to pick up and lay down sixty-three conventional type snap gages. Also imagine the saving in cost over that of conventional gages, bearing in mind that the latter would become obsolete the instant any one of the diameters of the rotors was changed in size.

The same principle of multiple inspection simultaneously is being applied to the inspection of shafts and shells (and other cylindrical objects) for *concentricity*.

Instrument Care Requires Less Than 1/100 of Time They Save

By J. M. PLUMMER
Leeds & Northrup Co., Philadelphia, Pa.

IN the manufacture of Portland cement, the firing of raw ingredients is an operation in which the use of control instruments makes the burner's job less strenuous while enabling him to burn a more uniform product. Here is a typical case:

A pair of 400-foot-long rotary cement kilns, fired by powdered coal, were being operated without instruments of any kind. The burners (one for each kiln) could judge the quality of product by its temperature-color and by its consistency. To hold

quality, they regulated the fuel-air ratio, the amount of fuel, the draft and the furnace pressure, by means of manual adjustments as they were instructed. These men were on the jump most of the time; they had hot, dirty and strenuous jobs.

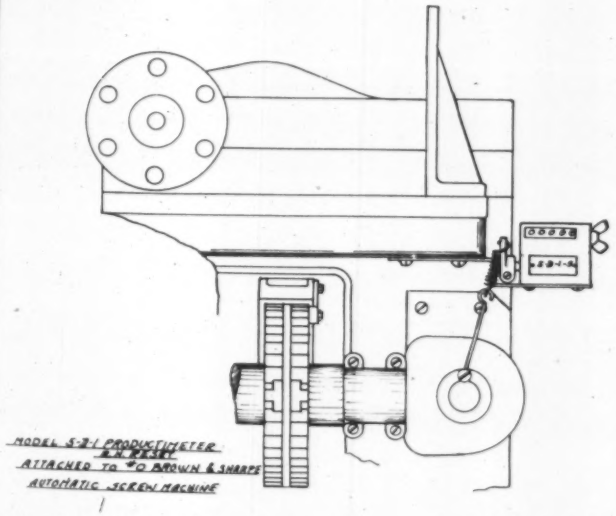
The first instruments added were fuel-air ratio controllers and L&N furnace-pressure controllers. Immediately the physical part of the burners' jobs eased up; they no longer had to adjust the dampers every few minutes. More important, the uniformity of the product was increased, because the instruments are more sensitive and faster-acting than even the best operator's eyes, legs and hands.

Shortly after the draft instruments were installed, Micromax pyrometers were added, and here the story changes. For, while the pyrometers help the men very substantially, they also show the superintendent what a good job the men are doing, and both the men and the boss like than. A little experience has convinced all parties concerned that the instruments tell the truth, and it is now felt that caring for the instruments doesn't require one one-hundredth of the time they save.

Standardized Counting Devices

By H. G. WEISER
Durant Mfg. Co., Milwaukee, Wis.

SINCE standardization means conservation, the Government urges every industry to use standard equipment as far as possible. Experience has shown that more than 80% of Productimeter applications can be filled by standard units, because the standard line of Productimeter industrial counting devices is very complete. These devices give accurate figures for production control, such as



output per machine; quantities of parts made; daily, weekly or monthly output—facts that enable management to keep a finger on the pulse of production. With standardized Productimeters on the job, costly over-runs and under-runs are eliminated; precious materials are conserved; valuable man-hours are saved.

Guesswork and costly hand count have no place in today's production schedule. Machines armed with standardized Productimeters do their part in helping to win the Victory.

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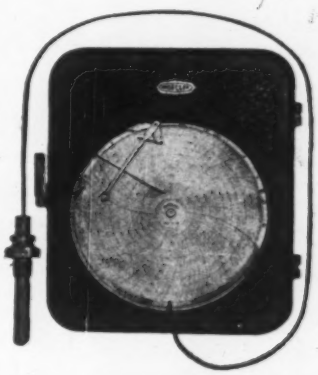

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H-B THERMOMETERS

Automatic Shell Gaging

By JAMES F. MAHER
Engineer, Winslow Indian Sanatorium, Winslow, Arizona

1. THE SHELL GAGING ARRANGEMENT

IT is my belief that a turning and reversing setup (such as described in my other contribution) could be used for the automatic inspection of projectiles which you advocate in your "Call for Ideas." Fig. 1 is my idea of such a setup, which is virtually a large micrometer beam, with contacts to indicate

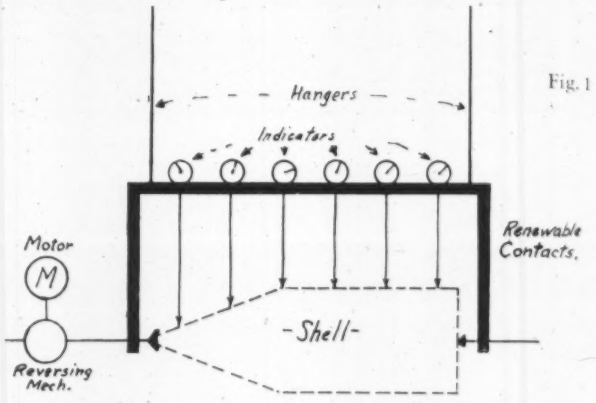

Fig. 1

variation in size directly or electrically on instruments. A "pattern" projectile or "standard" should be kept on hand for periodic correct setting of the contacts. The whole assembly could be put on a pivoted overhead hanger, and pick up the projectiles itself, or be fixed and the ammunition fed to it by a foot-operated elevating shell holder, the projectile held at the point by a cup center and by a point center at the other end. The projectile could be readily transferred by conveyor acting by use of the ice-tong principle, being held by its own weight in a cup center at one end and point center at the other.

2. THE AUTOMATIC REVERSING MECHANISM

I offer for consideration a low-cost and efficient mechanism, readily available in quantity, for use in *any* process or operation requiring automatic rotation and reversing.

This unit is made up of a differential from any used car. Essentially the principle of operation is the same as that used in the common engine valve grinder. The ring gear of the differential is discarded and the two inside gears which take the

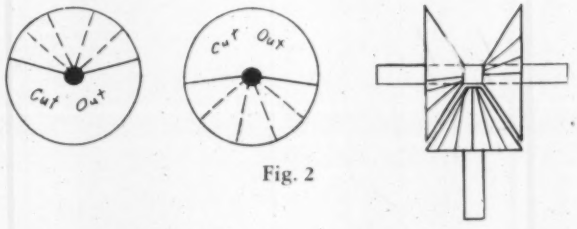

Fig. 2

splined ends of the axles are the important parts that need changing. A section of teeth is cut from one gear, and another section from the other gear. (See Fig. 2.) These two are to operate in fixed relation to one another, on a through shaft put through the holes formerly taking the axles, to which shaft they are welded. The shaft on which they are spaced, set, and welded, is driven by a

suitable motor and the gears in turn operate one of the small equalizing gears in the housing, the other being discarded or used for making up a spare driven gear. This one gear is welded to a shaft, with a suitable thrust bearing outside the case, which in some cases may be only a ring welded to the shaft, which shaft transmits the turning and reversing action. This action can be made to gain in either direction, as chosen, by leaving more teeth on one of the splined gears than on the other. The number of teeth cut out is so fixed that the equalizing gear travels over the section of teeth on the one gear, just clears them, and then engages the section of teeth on the other side, and so on.

There must be a relation between the two fixed gears so that the smaller equalizing gear can just clear the last tooth on one side before engaging with the first tooth on the opposite side.

The holes and bracket formerly holding the ring gear can be used for a mounting bracket. Depending upon the requirements of the operation, the setup can be used as described or reversed, by using a splined gear on the shaft to transmit the rotating and reversing motion, and with the two small equalizing gears providing the turning and reversing action.

We made up such a setup to grind large engine valves in one power plant, which greatly reduced the time over brace and bit hand grinding and did a much better job.

In using this setup, the transmission shaft should have no flywheel-effect, as a tendency to continue rotation will cause the gears to engage for the reverse action with considerable force and resultant consequences.

This mechanism is open for a variety of uses and is alterable to fit many situations.

Time Delay Relay for Automatic Control of Cotton Feeding Equipment

By R. S. PADEN

General Electric Company, Atlanta, Georgia

IN the opening room of a southern textile mill, cotton is removed from the original bale and is fluffed up into a loose condition by special machinery. At times, the cotton flowing into this machinery accumulates to such an extent that it overflows from the bin onto the floor, making it necessary to replace it manually in the feeder hopper.

To shut down the feeding equipment a lever-actuated mercury switch was applied which would trip when the cotton in the bin reached a predetermined level. This was not the whole solution, however, since the mercury switch was being constantly tripped by the continuously rotating cotton in the bin. This meant constant starting and stopping of the feeding machinery while the bin was full.

Supplementing the mercury switch with a G-E electron tube type time delay relay solved this vexing problem. Once the mercury switch has initiated a shut-down period, this relay shuts down the cotton feeding equipment for a pre-selected period of time, irrespective of the opening and closing of the mercury switch. After the time period has elapsed, the mercury switch can again start up the feeding equipment.

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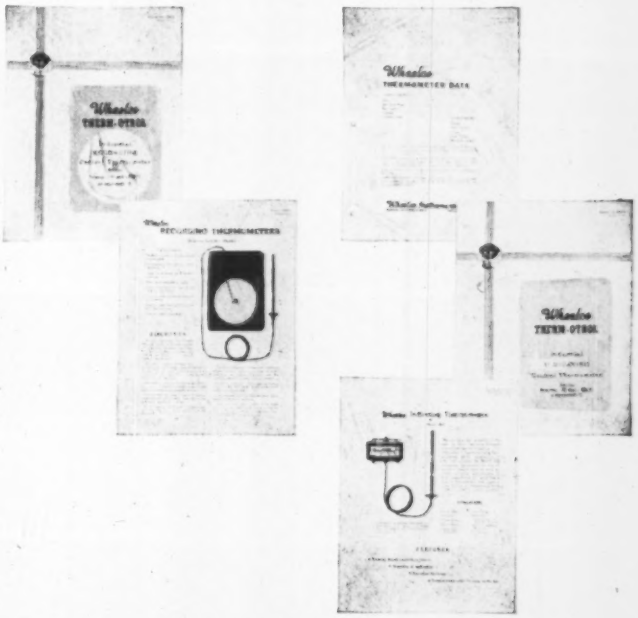

Wheelco has published five new Bulletins, which illustrate and describe various types of Thermometers and explain their function in relation to their intended application.

You will find a wealth of information in these Bulletins on Indicating Thermometers, Indicating Therm-otrols (Indicating, "Electronic Principle" Thermometer Controllers), Recording Thermometers, and Recording Therm-otrols (Recording, "Electronic Principle" Thermometer Controllers), all of which are available in ranges from —100°F. to +1000°F., or —70°C. to +550°C. Also illustrated and described are Thermometer Bulbs, Bulb Sockets, Capillary, Capillary Armor, Charts, Chart Ranges, Scale Ranges, etc. Explanation of how the Flame-otrol (combustion safeguard), Purging Timers, Program Control and Proportioning Control can be integrally incorporated in the various Thermometers is given.

Write for any one, or all, of these Bulletins without obligation.

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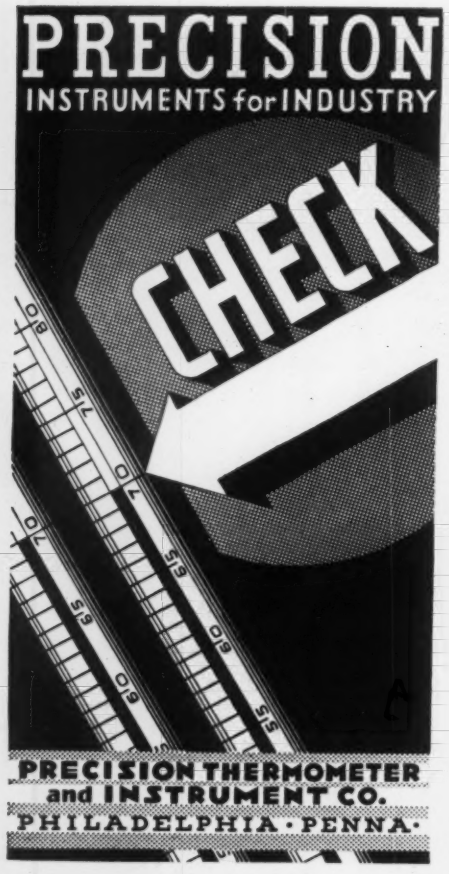

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Aircraft Electrical Instrument Testers

(Continued from page 11)

ice. The unit is essentially a vacuum-tube ohmmeter, with six resistance ranges. When the switch on the right is rotated it connects the bulb (which is plugged to the connector provided) into the proper circuit to test its resistance, shorts, opens, case leakage; and also to apply a high-voltage breakdown test as prescribed by Army technical order tests. At the various positions of the selector switch are colored dots, which correspond to colored flags on the instrument dial. The flags on the dial are of proper width to indicate either a good resistance element (within limits) or a defective unit (outside limits). The breakdown indicator is a small neon lamp. The test instrument is provided with external connector jacks so that it may be used as a wide-range portable ohmeter. It contains its own power supply, 110-volt 60-cycle.

Fig. 5 illustrates a portable test box for ranging and calibrating ratio-type indicators. Since the moving coils of these instruments operate on current differential instead of current strength, there being two separate coils on the moving element, it is necessary to adjust the range of the instrument by locating the eccentric core, before connecting the movement to its associated circuit. Without automatic testing equipment this operation would require extensive use of decade boxes, batteries, test leads and current indicators. By use of the instrument shown, the two moving coils can be connected to the three tip-jacks, and all adjustments computed from the dial readings. The unit contains an ohmmeter for measuring the resistance of each coil, a decade box which is connected in a bridge circuit together with the two moving coils and a fixed resistance of 3000 ohms. All connectings are made automatically by rotary and toggle switches. After the three hair-spring terminals are connected to the jacks, the coils are measured for resistance. Then the movement is ranged for correct ratio (1 to 1.8) by adjusting the decade resistor to low and high scale readings respectively. The readings obtained provide the figures from which to calculate the ratio and adjust the movable core until correct ratio is fixed. Pro-

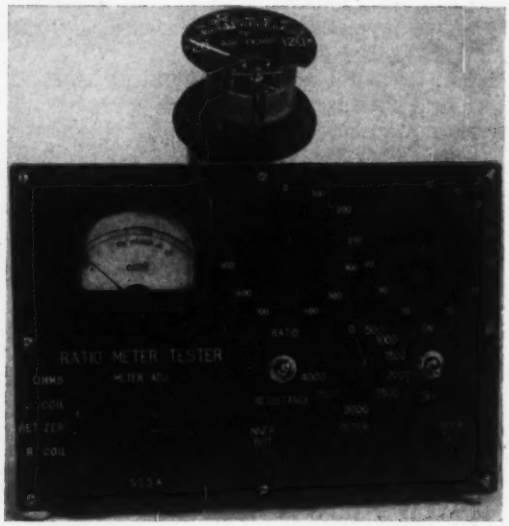


Fig. 5

vision for correcting the ohmeter to zero and self-contained battery make the instrument completely portable.

In Fig. 6 are shown front and rear views of a small altitude chamber with integral vacuum pump, for use in calibrating altimeters or rate-of-climb indicators. Though constructed from an aluminum pressure cooker and a pump from a fly-spray outfit, the equipment has been found to be very flexible and efficient. The speed of the pump is controlled by a 100-watt rheostat (left-hand knob) and the speed of exhaustion is controlled by a needle valve (right-hand knob on the front panel). The lid of the pressure cooker was cut out

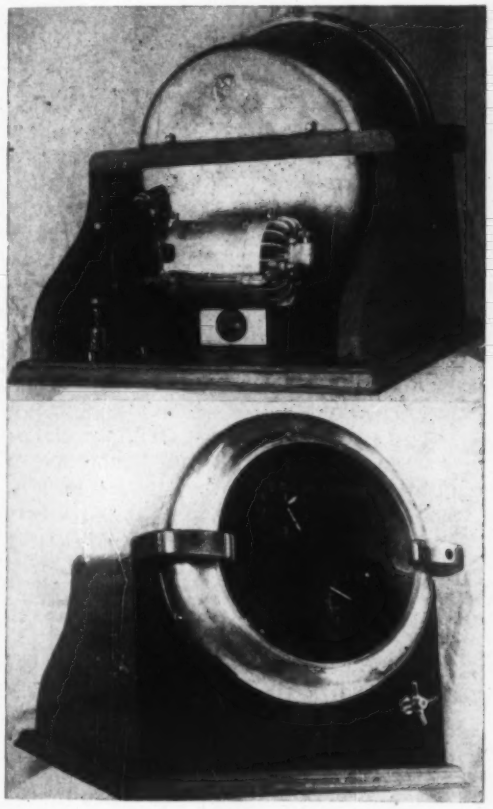
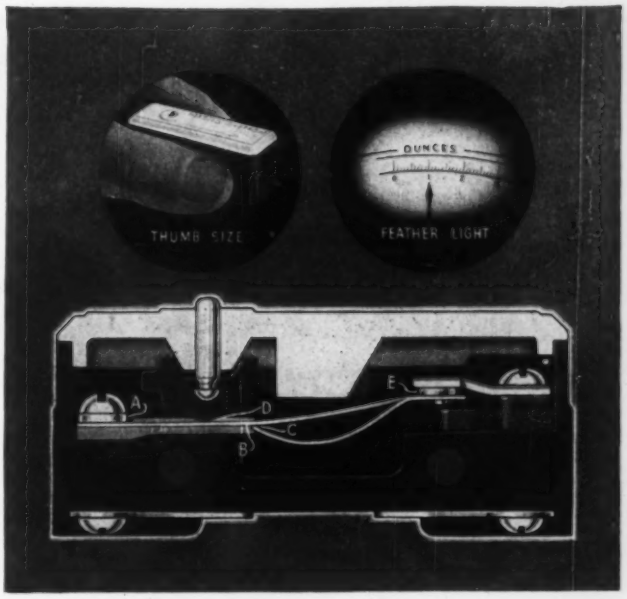


Fig. 6

on a lathe and a circular piece of heavy plate glass sealed into the opening. The construction of the pressure cooker is such that the front may be removed by a slight turn to the left, making for speed in testing these flight instruments. An altitude of 40000 feet can be reached in approximately two minutes, if desired, or controlled to as slow an ascent as required. A master altimeter, previously calibrated, is compared with the instrument under test. There is room in the case for three instruments at one time. Climb indicators are calibrated with a stop-watch and master altimeter.

An interesting story goes with the piece of automatic electrical testing equipment shown in Fig. 7. Students who assisted in its construction were preparing to engrave the front panel and inquired what name to call it. Since the unit is so versatile that it makes tests on at least sixteen types of electrical instruments, it was impossible to call it an "ammeter tester" or a "cylinder temperature tester" or "millivolt supply," so the name was left undecided for the time being. Later it was found



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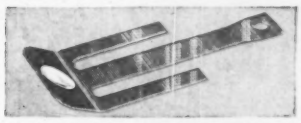
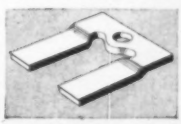
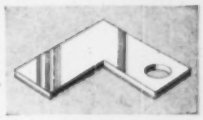
The Micro Switch design incorporates features that provide desirable performance characteristics not generally found in snap-action switches . . . The heat-treated beryllium-copper spring bends in the same direction as the operating plunger—no reverse bends—no "oilcan" action . . . gives longer switch life—accurate repeat action—increased contact pressure—lightning-fast action—millions of operations on minute movement and force differentials. It is the choice of design engineers for all types of sensitive instruments.



The beryllium-copper spring is made in one piece. It is gauged to an accurate .0085" thickness; has high resistance to fatigue. Ends of compression members are finished to provide an extremely low friction bearing. Contact end of the spring is fitted with a riveted radius type contact of 99.95% fine silver. It moves at a speed of 3/1000ths to 5/1000ths of a second with a rolling action and extremely high pressure.



Short spring members pivot in patented V-grooves of this sturdy brass anchor. Note the special shape of these grooves, which reduces friction to a minimum.



Stationary contact is a flat inlay of 99.95% fine silver. This construction assures ample over-load capacity and maximum heat dissipation.

Operating plunger is a highly polished stainless steel pin imbedded in an accurately moulded star-shaped Bakelite head. Provides long over-surface path to live parts, thus insuring freedom from electrical leakage. Plunger head cannot rotate within the housing, insuring against any variation in point of operation.

If you would like to know more about the Micro Switch, send for the two Handbook-Catalogs illustrated here—No. 60, which covers Micro Switches in general; and No. 70 which deals with specific Micro Switches for use in aircraft.

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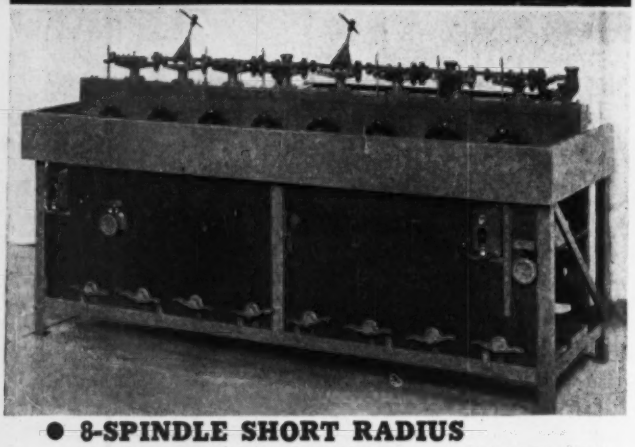

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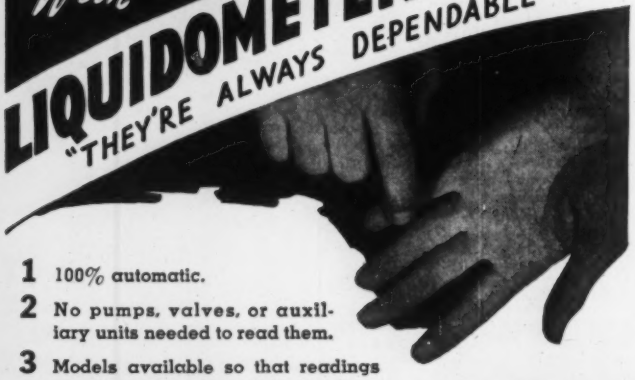

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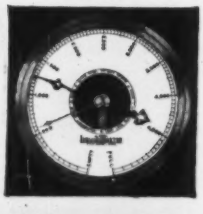

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Fig. 7

that the title "Wonder Worker" had been fastened to a label stuck on the panel, and the name has stuck. From that time until the present the instrument is called for and used under the title "Wonder Worker," and it is used every hour of the day. Like most wonder workers, the equipment is fairly simple. It is a variable millivolt supply, direct-reading on the microammeter scale instrument installed in the panel, with jack connections for calibrating all types of voltage-operated sensitive instruments. When connected to the proper terminals, aircraft electrical instruments are automatically connected with the proper resistance in the circuit, to duplicate actual installation conditions on the airplane. For cylinder temperature indicators, connection is made to the lower left pair of jacks, and the toggle switch immediately above thrown to "2 ohm" or "8 ohm" position as required. Millivolts for the various readings, Fahrenheit or Centigrade, are read from the microammeter while adjusting the potentiometer in the center. For 50-millivolt or 100-millivolt ammeters and volt-ammeters, the instrument under test is connected to the upper right tip jacks, and with the selector switch setting at the required position, the proper scale is connected to test sensitivity of these instruments. For Cambridge indicators the selector is moved to "Cambridge" and

Fig. 8

the indicator connected to the upper left tip jacks, where the proper resistance is included in the circuit, and the instrument ranged for proper sensitivity. By use of the lower right tips jacks and the multi-range selector at the left, the unit may be used as a millivoltmeter in combination with any other instrument or power supply. When used in this fashion the internal power supply and voltage divider system is automatically disconnected.

The tester shown in Fig. 8 makes all tests called for in the Army manuals. The transmitter is plugged into the standard AN socket on the panel and all readings are direct on the indicator when the rotary switch is set in the proper one of its five positions. Limits are shown on the dial by colored bands.

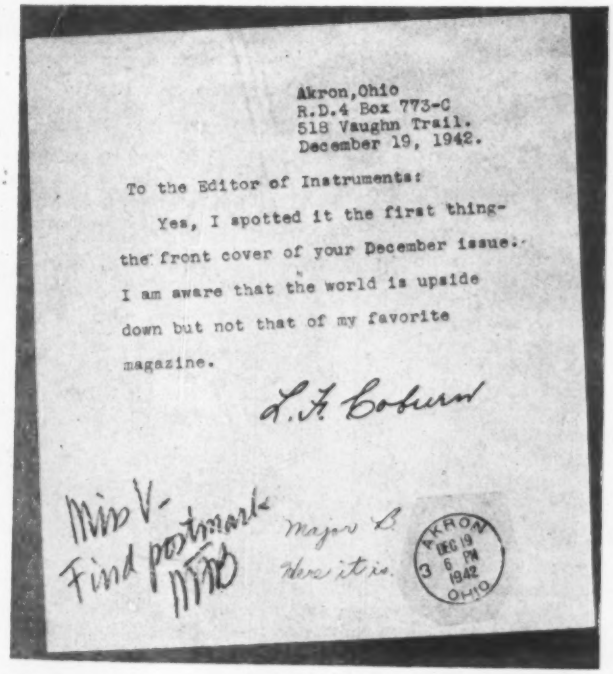
Reduction of Eye Fatigue

By WILLIAM NAKEN
Dayton, Ohio

WHEN making a number of tests involving the use of electrical measuring instruments in which the pointer is watched for movement (as when balancing a bridge circuit) eye fatigue may be lessened by directing a light toward the pointer in such a manner as to cast a shadow of the pointer on the scale, thereby permitting the eye to watch the shadow of the pointer rather than the pointer. This method was tried and found to work successfully.

WINS $50 WAR BOND

'Twas them Gremlins! Yes, while the cover of our December issue was being printed, them Gremlins got into the press, caused a stoppage and inverted the control-board



Akron, Ohio
R.D.4 Box 773-C
518 Vaughn Trail.
December 19, 1942.

To the Editor of Instruments:

Yes, I spotted it the first thing- the front cover of your December issue. I am aware that the world is upside down but not that of my favorite magazine.

L. F. Coburn

Miss V- Find postmark Major B Here it is.

AKRON DEC 19 3 6 PM 1942 OHIO

halftone, so that the rest of the copies were printed with the picture upside down. Moreover, them Gremlins caused *these* copies to be mailed out before we could detect the error. Subscribers' comments ranged from sarcasm to sympathy. Quickest to dash off and mail us a note was Old Subscriber Coburn—who thereby (and to his surprise) won a $50 War Bond.

MASTER MULTITESTER

A. C. & D. C. VOLTMETER • D. C. AMMETER • CAPACITY & INDUCTANCE METER

The original engineering design features of this precision Master Multi-tester makes it ideal for a large variety of tests in both the laboratory and factory. Incorporates the exclusive R.C.P. system of A.C. measurements eliminating the troublesome copper oxide rectifier. Rectifier used is rugged, extremely sensitive and easily replaced. A.C. scales are practically linear and coincide with D.C. scales. Capacity measurements are direct reading. Ohmmeter has self-contained power supply. Meter sensitivity 2000 ohms per volt. D.C. voltmeter range: 0-5-50-250-2500-5000. A.C. voltmeter range: 0-10-100-500-1000-5000. D.C. milliampere range: 0-10-50-250-1000. D.C. ammeter range: 0-1-5-25. Capacity meter range: 0-.03-.3-3-30-300 mfd. Low ohm scale: 0-100. Center ohmmeter scale range: 0-15,000-150,000. Megohm scale: 0-.1-.5-15. Inductance meter: .25-1000 millihenries — .25-100-1,000-10,000 henries. Meter and power line completely fused. Supplied in handsome, black crackle wear-resistant steel case. Operates on 105-135 AC power supply. Model 414 V-7 ready for operation . . . $36.95.

Other instruments in the complete line of R.C.P. electronic and electrical test instruments described in catalog No. 126. If you have an unusual test problem—either for production line or laboratory work—our engineers will be happy to cooperate in finding the most efficient and economical solution.

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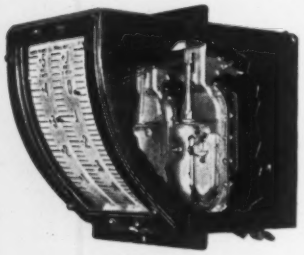
Multi-Pointer Gages for indicating drafts, pressures, differentials are available with any number of pointers from one to twelve. They are actuated by sturdy yet sensitive diaphragm units.



Multi-Pointer Gage

Flow Meters. For indicating, recording and integrating the flow of steam, feed water, compressed air and other fluids.

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Granular Material Meters For accurately measuring the flow of coal or other granular materials in gravity chutes from overhead bunkers. The total quantity of granular material is shown on a large illuminated counter which may be easily read at a distance of 50 feet.

Control Systems Make possible the everyday operation of equipment for steam generation and utilization at test efficiencies. They are applied to the control of combustion, feed water, superheat, desuperheat and other factors.

Complete Information on any of the above Bailey products will be gladly furnished upon request.

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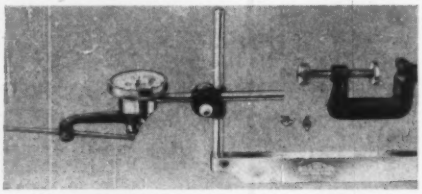
The Month's NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department as your source of information. Or write to Information Section, Instruments Publishing Company.

Universal Test Indicator

New "Universal Test Indicator No. 22A" is small and compact, easy to set up and adjust, can be used on numerous testing jobs and, with Hole Attachment, can reach internal surfaces and places that are hard to get at. Complete set includes all parts shown in illustration: indicator "No. 101H," three contact points of different lengths; indicator holding rod; hole attachment; tool post holder; upright spindle; swivel and C clamp; also sliding-cover wooden box.—*B. C. Ames Co., Waltham, Mass.*

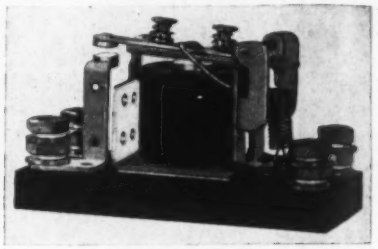


Fuel Level Transmitter for Aircraft

New "Type TJ-18" vertical form liquid-level transmitter, for measuring fuel level in tanks of heavy bombers, is 72" long, so that it will reach to bottom of tank, yet weighs 7 lbs. (It can be furnished in snorter or longer lengths.) *Operation:* as liquid level changes, a laminated-cork float traveling on a square shaft inside vertical tube is rotated by a spiral guide, cut in the vertical tube, and thus turns the square shaft, whose position is indicated on instrument-panel receiver by means of a d.c. Selsyn telemetering system. Transmitter can actuate any of several types of indicators. Moving element is suspended from top bearing, bottom bearing serving only as a guide. There is no stuffing-box: magnetic coupling is used between float mechanism inside tank and transmitter outside tank, so that unbroken walls provide a positive gasoline seal.—*General Electric Co., Schenectady, N. Y.*

Aircraft Relay

New "B-2-A" relay, designed for remote control of aircraft electrical circuits and built to U. S. Army Air Force specifications, has a contact rating of 25 amps. continuous and 100 amps. surge at 24 volts d.c. It has s-p.s-t. normally-open contacts, weighs 6 ounces. Manufacturer claims unit has acceleration and vibration resistance over 10 *G*. Metal parts are heavily plated to withstand 200-hour salt spray test. Designed primarily for aircraft, unit is said to have numerous applications in other industries. — *Guardian Electric, Dept. B-2-1, 1609 W. Walnut St., Chicago, Ill.*

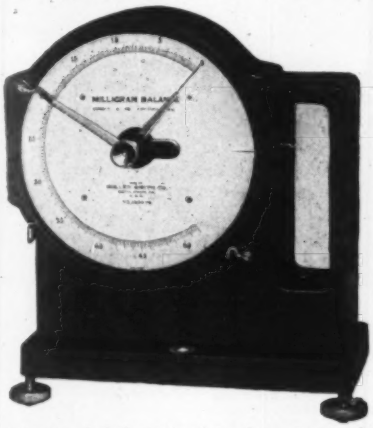


Small Light-weight Instantaneous Auxiliary Relay

New "Type HMA" instantaneous auxiliary relay, designed to meet lightweight small-space specifications of Army, Navy, and Air Corps specifications, weighs 9 oz. and measures 1⅞" × 2¾" × 2 9/16" with its cover. Its base, cover, and moving contact supports are of one-piece molded Textolite. Available styles: d-p.d-t. with single-break contacts; s-p.d-t. with double-break contacts brought out to a terminal. It can be obtained back- or front-connected; with or without cover. Relay contacts are silver-to-silver, self-aligning, and will interrupt 1 amp. at 125 volts d.c. inductive load.—*General Electric Co., Schenectady, N. Y.*

Precision Balances

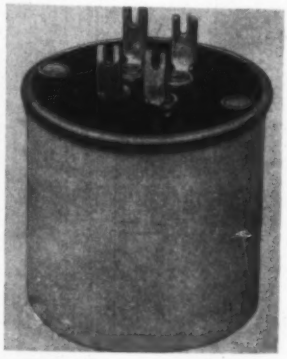
To meet the need for accurately-weighing instruments that can be used by unskilled or semi-skilled workers, two new models of Roller-Smith Precision Balances are available in various sizes for weights ranging from less than 3 mg. to more than 50 grams. Both are modified designs of "Model B" which has been used in industrial



plants and laboratories for a number of years. "Model B-1" is available in double-hook type only while "Model MB" can be furnished in single-hook or double-hook types. The only other difference between the two is that the MB balance is provided with a weighing chamber to protect the hook and weighing sample from drafts. Both have a guaranteed accuracy of ⅕ of 1%. In the single-hook balance, the material to be weighed is hung on the hook and the index lever moved until the parallax pointer fastened to the beam indicates zero. The index pointer attached to the index lever then indicates the weight of the object. Double-hook balances operate in the same manner except that the second hook is provided so that counter-weights can be used to increase the capacity of the balance to a maximum of three times normal.—*Roller-Smith Co., Bethlehem, Pa.*

Transformer for Extreme Temperature and Humidity

For communications equipment intended for service in regions of extreme climatic and weather conditions,



Thermatite-treated transformers are announced. Thermatite is said to be a new "tested and approved" form of impregnation.—*Thermador Elec. Mfg. Co., Los Angeles, Calif.*

New CABINET MAKES ACCURATE TESTS AT *Low* AND *High* TEMPERATURES!

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Uniformly accurate tests are made by the Amcoil Model RTC-1, an all-steel test chamber combining mechanical refrigeration and electric heating.

It ranges from minus 55 degrees C. to plus 70 degrees C. Interior content: 28.7 cubic feet. Thermostatic control. Should reach minus 50 degrees C. in approximately one hour, without production load. Front panel board accurately controls entire operation. Five thicknesses of glass in door afford clear visibility of instruments under actual test.

Amcoil engineers can help you determine your testing requirements. In addition to the RTC-1, there are other Amcoil chambers with mechanical refrigeration and dry ice, also for altitude testing. Let us advise you on the type of equipment best suited to prove your instruments *under war conditions.*

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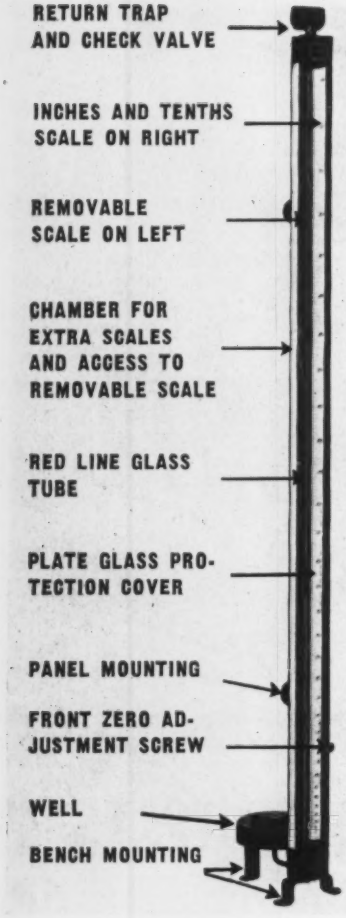
RETURN TRAP AND CHECK VALVE
INCHES AND TENTHS SCALE ON RIGHT
REMOVABLE SCALE ON LEFT
CHAMBER FOR EXTRA SCALES AND ACCESS TO REMOVABLE SCALE
RED LINE GLASS TUBE
PLATE GLASS PROTECTION COVER
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AIR SPEED INDICATORS
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THIS new multi-removable scale well type manometer incorporates a chamber at the rear of the instrument to hold the reserve supply of scales, so that any scale reading may be made by means of inserting the desired aircraft scale in the instrument and then making direct readings on the instrument.

The instrument incorporates a front scale adjustment, of fully enclosed type construction, with red lined heavy wall pyrex tubing and external return trap and check valve, preventing blow-over of indicating fluid.

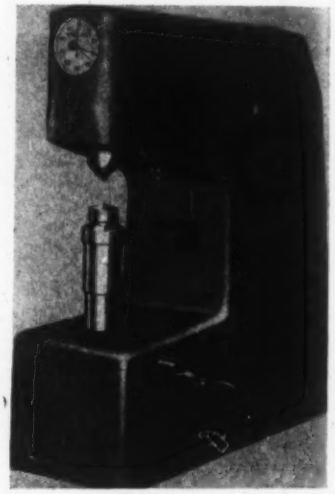
Standard construction includes inches and tenths scale on one side and removable aircraft scale on the other. Unit is adaptable for bench or front of panel mounting.

For complete data and prices, write today.

TRIMOUNT INSTRUMENT COMPANY
408 SO. PLYMOUTH COURT CHICAGO, ILLINOIS

Production Hardness Tester

New "Steeltest" production hardness tester is designed for volume hardness testing with a maximum capacity of 2400 determinations per hour. Provision has been made for hopper-feed continuous or hand-feed single-cycle operation. Conversion from continuous to single-cycle operation is instantly made by a switch which controls an electrical braking system. Direct readings showing actual hardness numbers in all



standard Rockwell scales are given on a 100-division dial. No charts or comparison tables are required. Adjustable maximum and minimum indicators are provided for tolerance limits. Diamond penetrator is standard 120° cone with 0.2 mm. radius, interchangeable with chucks for $\frac{1}{16}$" and $\frac{1}{8}$" steel balls. Dead-weight loading system applies 10-kg. minor, and 60-, 100- or 150-kg. major loads, through a compensated loading beam actuated by a direct-coupled uniform-motion cam drive. Power supply is $\frac{1}{15}$-h.p. 60-cycle, 110-volt a.c. arranged with a 60-to-1 reduction unit. No dash-pot is employed and operation is not affected by climatic conditions. Hardness testing is practically automatic, the only manual operation being the elevation for initial setting of one specimen in each batch run, and the feeding of the specimens. Correct initial setting is assured by a red flasher signal located at operator's eye level.—*Steeltest Instrument & Mfg. Company, 14212 Fenkell Ave., Detroit, Mich.*

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A high grade instrument for measuring resistances from a fraction of an ohm to 10 megohms. Contains a 4-dial rheostat, ratio dial, galvanometer and battery, all enclosed in a substantial walnut case. Nine coils per dial. Accuracy .1%. Built to endure.

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D.C. 1 microampere to 1 ampere
20 microvolts to 1000 volts
A.C. (up to 3000 cycles)
2 milliamperes to 3 amperes
60 millivolts to 1000 volts

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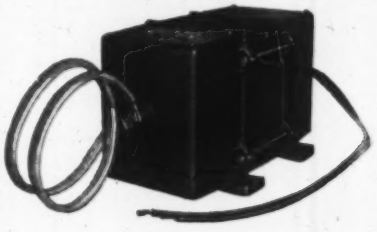
Interference-free Transformer for Test Purposes

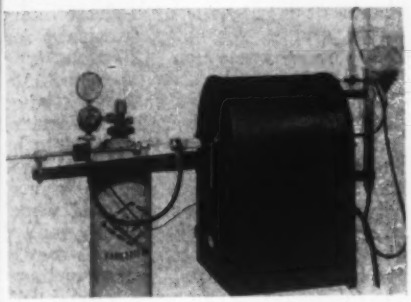
Testing of radio and communication equipment, especially for Signal Corps or other Service Branch use, requires special accuracy. Usual practice is to test such equipment within a shielded test-room, but radio interference can enter by means of the power line. To eliminate such interference, Acme Type



T-4173 Isolating Transformer makes use of a secondary completely enclosed in a copper shield. Secondary terminal connections are provided by means of a lead-shielded cable, the sheath of which is integrally joined to copper enclosing shield of secondary winding. Manufacturer claims that Isolating Transformer normally rated at 2 kva. is capable of handling a total load of 3 kva. Regulation of transformer is 1% at 1 kva. Inside the shielded testroom soldering irons, instruments and various types of test equipment may all be operated from the shielded secondary, the load being switched on and off without affecting the relatively constant voltage necessary for accurate testing.—*Acme Elec. & Mfg. Co., Cuba, N. Y.*

Gas-content Determinator

New Gas Determinator has been developed for determining the gas content of cores and molding sands. It consists primarily of a "Varitemp" Combustion Furnace (see *Instruments*, July 1940, page 174) equipped with a gas measuring burette mounted on the furnace, a combustion tube, a magnetic boat push and a gas pressure regulator.



All of these parts form an integral unit of the combustion furnace. Test procedure: place 3 g. sample in combustion boat; place boat in cold end of combustion tube and close the end of combustion tube with magnetic boat pusher assembly; push boat into hot zone. Sample is usually burned in a CO_2 atmosphere, may be burned in any atmosphere chosen. Rate of gas evolution and volume of gas formed are read from the burette. Gas Determinator may be used to determine gas content of many materials, to determine actual see coal content of molding sands, etc. —*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.*

25-ampere Aircraft Relay

New "Diamond-H" solenoid type 25-amp. aircraft relay is built to conform to U. S. Army Air Corps specifications (type B-2A) and features a rigid cap which protects the relay from dust—a matter of extreme importance in many applications. Cap also reduces danger of mechanical damage and consequent possibility of failure. It is claimed that low-capacity relays are becoming invaluable in remote control of aircraft sub-assemblies (such as fuel pumps, landing lights and gun firing controls). New unit is built to the same standards as maker's high-capacity line, hence is expected to find numerous applications.—*Hart Mfg. Co., Hartford, Conn.*

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ACCURATE RESISTORS—SWITCHES—SPECIAL EQUIPMENT AND
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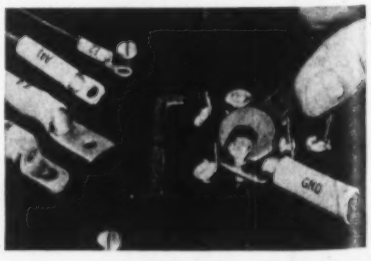
Generator Voltage Regulator

New "GL-1" voltage regulator is applicable to small a-c. generating plants having separate exciters; will satisfactorily control individual generating units operating in parallel with other generating units by using automatic cross-current compensation; may be used on an exciter whose maximum field current does not exceed 1.4 amp. at maximum exciter voltage while exciter is connected to alternator field

(125-volt exciter). It is suitable for control of single-, 2- or 3-phase alternators and is normally furnished for 50-60 cycle operation (25-cycle type special). It can be furnished for 110-120 volts or for 208-240 volts. Higher voltages require potential transformers (p.t. burden 120 va.). It is said to be ideal for portable applications. Vibration and tilting do not affect it appreciably because of low inertia of vibrator. Sensitivity (amount of voltage change required to bring about corrective action) is ±0.25% normal voltage. The GL-1 may be expected to hold voltage to within 2% or normal rating when generator load is varied from no load to full load and back again to no load, such change taking place gradually. It acts swiftly to apply correction for a voltage change. There are no dashpots, heavy elements, relays, or other damping means to retard action. Limiting factor of voltage recovery is generally considered to be the time lag of the generating unit itself. Weight 10 lbs., height 9", width 6½", depth 4½".—*Burlington Instrument Co., Burlington, Iowa.*

Insulating Wire Markers

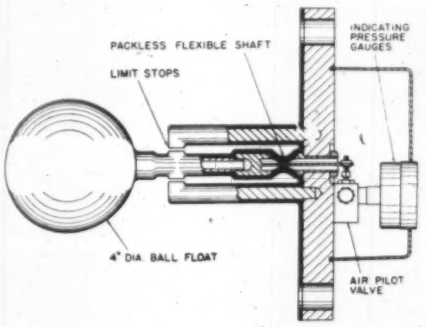
Short lengths of extruded plastic tubing, clearly marked with letters and numerals, serve both as insulators of terminal connections and as wire markers. Where lug insulation and wire identification are required, they speed assembly by eliminating any additional means of identification. Tubing from which they are made is said to have



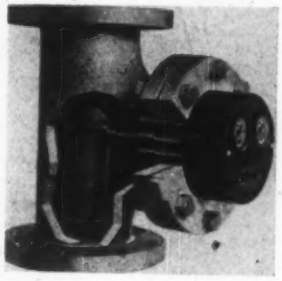
"very high" dielectric strength. Smooth inside surfaces permit quick application over wires and lugs. Printing is with an ink that has resistance to chemicals, water and oils equal to that of tubing itself. Available in colored tubing with either black or yellow symbols, in A.S.T.M. sizes from No. 9 up to ⅜" I.D. (For larger sizes, consult manufacturer.) Other tubing made from much less critical plastic materials can be printed and utilized solely as wire markers.—*Irvington Varnish & Insulator Co., 6 Argyle Terrace, Irvington, N. J.*

Rubber-covered Liquid-level Controller

New completely rubber- or neoprene-covered liquid-level controller is designed for installation in a standard rubber-covered tee fitting, or for direct



mounting in a tank containing corrosive fluids. Rubber-covered steel flexible shaft eliminates packing glands and bearings, also transmits float motion frictionlessly to an air pilot valve, Micro-switch, etc. Flexible shaft consists of a formed tube similar to a Bourdon. A flat lever inside this tube connects directly with pilot valve or



switch. Operation is not affected by wide variations of pressure and temperature. Rubber-covered stops keep flexible shaft well within its elastic limit. Operating principle: force change due to buoyancy. Sensitivity: a buoyancy change of less than 8 oz. results in full travel of diaphragm valve. This permits use of small (4") ball float and short float arm. Interface level control of liquids having specific gravity difference as small as 0.05 can be obtained by using larger floats and longer float arms. Elliptical steel floats having ⅛" rubber covering are used where wider level changes are desirable. For high and low level cut-off or alarm, a Micro-switch can be furnished in place of air pilot valve.—*Moore Products Co., H and Lycoming Sts., Philadelphia, Pa.*

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The Arnold Engineering Company produces all **ALNICO** types including **ALNICO V.**

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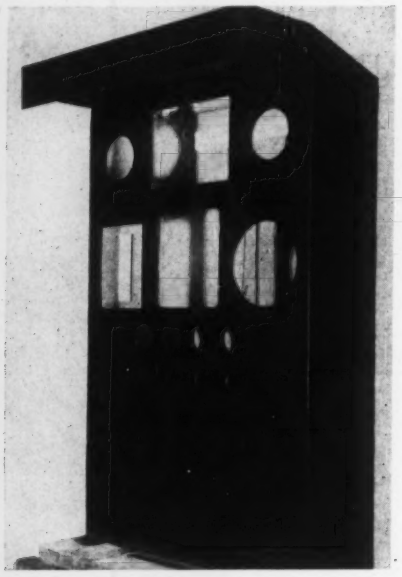
Masonite Panels

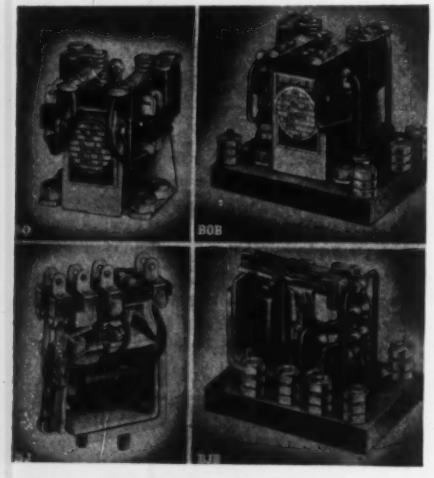
To conserve sheet steel, instrument and control panels of Masonite reinforced with steel angles are made available. Body of panel is cross-grained



Masonite 5/8" thick bolted to a framework of 3" × 3" angle steel. Braces of 2" × 2" angle steel reinforce center of panel to insure adequate support for measuring and controlling instruments. Canopy and doors, cross-grained Masonite 5/16" thick. Masonite is a hard material, takes a finish comparable to steel. In order to match standard Hays steel panel finish, Masonite panel is gone over with a sanding surfacer; priming coat is sprayed on and rubbed down to a smooth base; then several coats of undercoater sanded and rubbed. After thorough drying, finishing coats of black lacquer are sprayed on, giving lasting velvety finish. Inside is finished with two coats of gray lacquer. After instruments are in place, it is difficult to distinguish new Masonite panels from steel panels.—*The Hays Corp., Michigan City, Indiana.*

Small Power Relays

Maker's Models "BO" and "BJ" power relays for flight, firing and communication control have been redesigned to require minimum mounting space



and to permit variations in their mounting bases to make them widely interchangeable. They are now available with mounting bases of Bakelite, screw or shake-proof nut, etc. Features include easily accessible terminal connections and a semi-balanced armature to withstand vibratory motion with minimum coil power. Specifications of "BO": contact ratings, non-inductive, 15-amp for 12- and 24-volts d.c. and 110-volts a.c.; s.p.d.t. or d.p.d.t.; weights, 4 oz. with screw or shake-proof nut mounting or 7 oz. with Bakelite mounting; withstands vibratory motion to 12*G* with 2½-watt power; operating temperature range +70°C. to −50°C. Specifications for "BJ": contact ratings, non-inductive, 5-amp. for 12- and 24-volts d.c. and 110-volts a.c.; s.p.d.t. or d.p.d.t.; weights, 2¼ oz. with screw stud mounting or 5¼ oz. with Bakelite mounting withstands vibratory motion to 12*G* with 2 watts power; operating temperature range +70°C. to −50°C.—*Allied Control Co., New York City.*

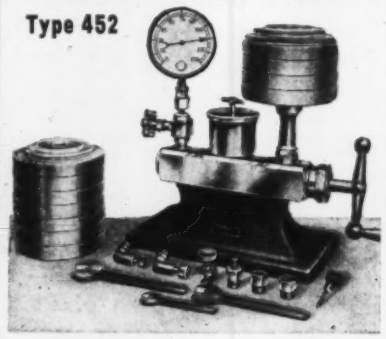
Heavy-duty Instrument Cleaning Machine

New "Heavy-duty Precision Cleaning Machine" has two baskets: one is 2⅝" I.D. × 2¼" deep; the other is triple, consisting of a retaining frame which

holds three individual small baskets each measuring 1⅞" × 1¾" deep. In addition, under each of the triple baskets is a sub-basket, 2⅛" long × 1⅛" wide. The mesh of these units is divided into two cups ⅞" wide × ⅜" deep each. New machine is for cleaning small jeweled bearings, instruments, ball bearings, extruded metal parts, small motor assemblies, pinions, jewels, watches, diaphragms, cylinders, etc. It is said that through its use, cleaning problems that formerly required large trained staffs may now be licked by an average individual in a matter of minutes, sometimes less than 10, averaging no more than 15. As many additional sets of baskets as are needed may be obtained so that, when necessary, every group of small parts cleaned may be kept in its respective baskets until needed for assembly. The "Heavy-duty" is, in spite of its name, a portable machine weighing ready for use under 50 lbs. Dimensions 13" × 15" × 18" overall height.—*L&R Mfg. Co., 54 Clinton St., Newark, N. J.*

AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



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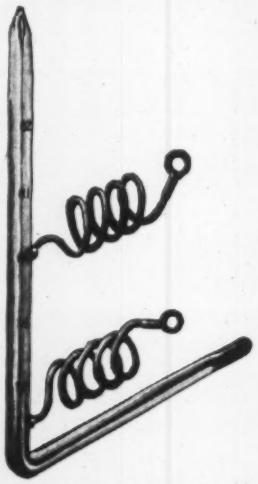

● Sensitivity of a hundredth of a degree is easily attainable. ● Top of mercury column visible at control point (where most important) because electrodes terminate at back of tube. No encircling metal bands! ● Available in angle form (illustrated) or conventional straight form. ● Send for brief, attractive bulletin.

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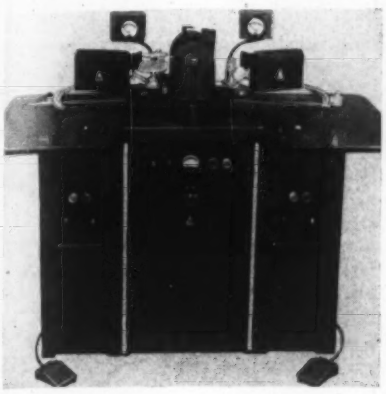
X-ray Crystal Analysis Apparatus

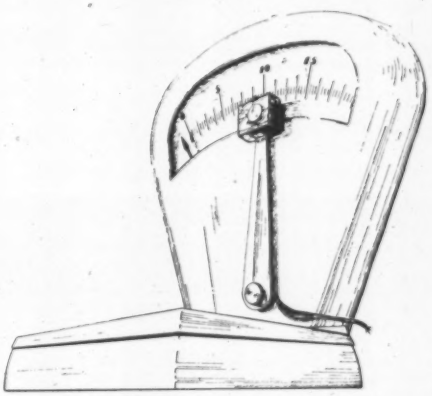
New X-Ray Crystal Analysis Apparatus is a practical production tool said to provide "the most important advance in fast, precise angle measurements of



mother quartz, sections, bars, wafers and blanks, with a wide choice of analysis methods depending upon character of quartz piece to be measured." It is claimed that tests can be made in a fraction of the time previously required and with relatively unskilled personnel. Unit will enable a manufacturer of crystals to predetermine characteristics of oscillator by maintaining the basic cutting angle. Saw tie-ups are reduced; improperly-cut material can be eliminated before finishing operations; rejects can be minimized. Apparatus is completely shock-proof and ray-protected. It has two working positions: left hand position for natural-face orientation, right-hand position for checking of blanks after cutting angles have been determined. But unit is designed for flexibility and it is possible to remove orientation table and use both positions for checking blanks. Equipment consists of a Philips Metalix Type No. 37000 x-ray tube with two Lindemann glass windows and horizontal filament for greater output. The x-rays are then received in an ionization tube. Circuit of ionization tube comprises ionization tube, amplifier, power source and indicating instrument (which does not have to be calibrated to read energies).—*Philips Metalix Corp., 419 Fourth Avenue, New York City.*

Photoelectric Prime Relay for Pointer-and-scale Instruments

New "Automatic Photo-electric Cut-off," illustrated as applied to weighing devices, is equally adaptable to pointer-and-scale instruments. Equipment comprises: (1) Scanner containing a light source, a photocell and an amplifier tube. (2) A 5" × 9" × 3½" deep housing containing an amplifier and relay. Scanner should be so mounted that its position is adjustable for operation



throughout indicating range of instrument. Operation: (1) Position of Scanner is adjusted to point on scale at which actuation is desired. (2) Light source within Scanner projects a beam of light, through an aperture, to scale face, which may or may not cause reflection back to photocell. Reflection from scale face is unimportant since it is the contrast in reflectivity between pointer and scale face that effects operation. (3) When pointer intersects light beam, light reaching photocell is decreased; resultant electrical impulse receives a first stage of amplification from amplifier tube in Scanner. (4) Through the control amplifier, this impulse causes actuation of the power relay which in turn commands a final control element. Accuracy of this method of control corresponds to that of the instrument. Sensitivity is claimed to be such that adjustment of position of Scanner provides operational control "at exactly the point desired." Numerous applications are listed in announcement but *Instruments* readers need no list. Mention may be made, however, of maintaining a variable within minimum and maximum limits by utilizing two adjustable Scanner heads.—*United Cinephone Corp., Torrington, Conn.*

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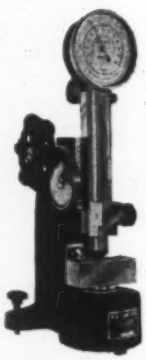

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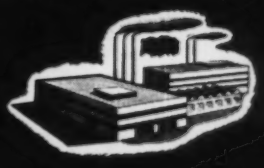

AN ENGINE MANUFACTURER

SOME engine pistons have hollow castings of intricate interior construction. Even after the most careful flushing, particles of sand from the casting core sometimes remain to make trouble. And serious trouble it is, for when the sand is washed out by the engine's lubricant, it is very likely to score cylinder walls and produce a serious breakdown.

When this problem was presented to Perkin-Elmer engineers, it took just twelve days to design and produce a device which, according to the engine manufacturer, has completely overcome this danger. It is a relatively simple optical instrument, similar to a physician's bronchoscope, enabling inspectors to explore every piston web and pocket. Stray particles of sand are quickly located and removed.

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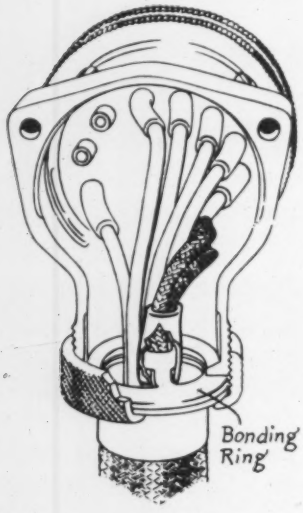
Bonding Ring

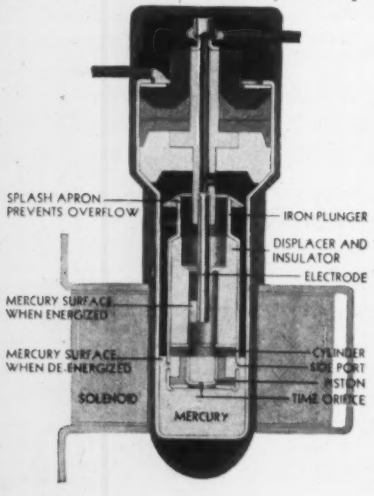
New Cannon Bonding Ring may be used wherever there is a need for bonding between electrical plug shell and wire shielding, and may be used with

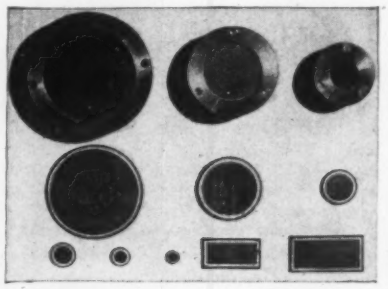


either flexible conduit coupling nut or cable clamp. Ring is suitable in bonding shielded radio and instrument circuits and is adaptable to many other applications where a tight bond is required. Available sizes and styles fit a variety of conduit nuts.—*Cannon Electric Development Co., 3209 Humbolt St., Los Angeles, Calif.*

Time Delay Relays with Inert-gas Quench

Mercury and electrode contacts of new "BFV" time delay relay operate in an atmosphere of inert gas under pressure, preventing contacts flaming and burning apart (which alters time settings). Type BFV illustrated is of 30-amp. rating and is one of many time delay relays of generally similar design but available in various ratings, forms and types of relay action. This particular type delays its action upon closing of the control circuit and, after such delay, closes the main line circuit, and upon opening of the control circuit the main line follows instantly to an open position. Such action is called "slow operate, quick release." The reverse of this is available, or "quick





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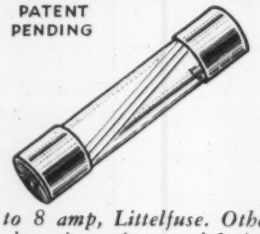

4 to 8 amp, Littelfuse. Other Underwriters Approved 3 A G Littelfuses 1/100 to 3 amps.

SPACE-SAVING

Many requirements that formerly had to depend on bulky cartridge, or plug fuses and mountings, now benefit by these fuses.

There are Littelfuses high and low voltage, mountings, fuse, clips, etc., for every instrument purpose. Panels and fuse protection engineered to requirements.

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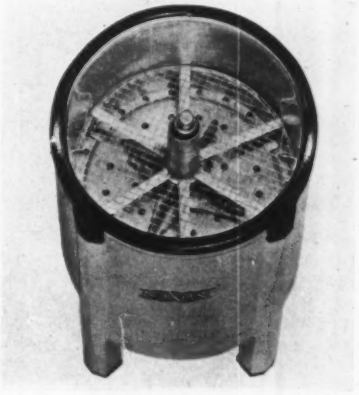
operate, slow release." It is applicable also to recycling operations, or "flasher action." Models are available in capacities to 75 amps., with solenoids wound for any voltage and frequency.—*Durakool, Inc., 1010 N. Main St., Elkhart, Md.*

Instrument Cleaning Machine

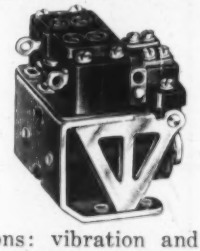
New "Naxon Instrument Cleaner" is designed for cleaning, by means of a solvent such as carbon tet, instrument assemblies and small parts, which are



placed in six segmental baskets all resting on screen (visible in illustration) but capable of being lifted one at a time. Double-wall housing encloses driving mechanism, agitator, screen and trays, removable porcelain-enameled tub, etc. Drain well and drain connection facilitate use of machine which, being mounted on casters, is readily moved from place to place. Dimensions: 18" diam., 26" high.—*Naxon Utilities Corp., 2101 W. Walnut St., Chicago, Ill.*

Aircraft Relays

New "Type 27" relays, designed specifically to meet requirements of modern aircraft, are said to offer a combination of "characteristics, operating efficiency and mechanical construction which justify their being called Super Aircraft Relays." Example: one relay built to satisfy the requirements of a specific customer meets the following



specifications: vibration and acceleration, 15 *G;* altitude, 40,000 feet; contact pressure for double-make, double-break contacts, 50 grams; contact capacity at 30 volts d.c., 20 amps (inrush 100 amps); 200-hour salt spray test; pick-up, at 20°C. 5 volts (0.36 watt); nominal coil voltage, 14 volts d.c.; coil wattage at 14 volts d.c. at 20°C. 2.8 watts; temperature range, −40 to +90°C. Dimensions 1½" × 1⅝" × 1⅞"; weight 5 oz. Electrical characteristics can be varied over a wide range to suit the requirements of different applications. Box frame construction is said to provide compactness, strength and sturdiness. Contacts are mounted in an open-

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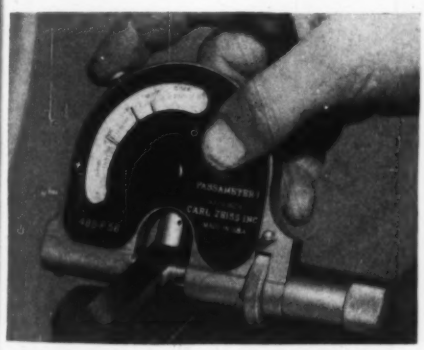

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An adjustable snap gauge of high precision, the Passameter covers the entire range of dimensions within its capacity of 0 to ¾".

Eliminates feel and skill of operator as factors in accuracy. Practically constant ideal pressure of 2 lbs. Zero in center of scale makes it easy to check approach to tolerances. Protected against dust and water by an all-enclosed frame. Each measurement reduced to one operation as against two with ordinary snap gauges.

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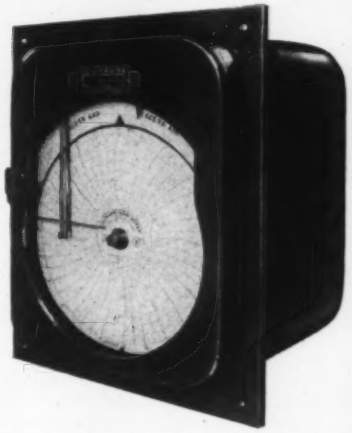
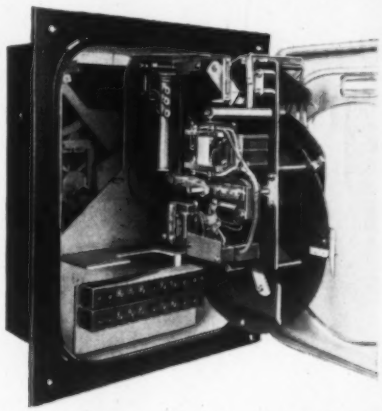
sided phenolic box for protection against damage and dirt. (Free samples of this relay may be obtained by relay users by requesting Specification No. 12723 and supplying a priority of A-1-K or better.)—*GM Labs., Inc., 4326 N. Knox St., Chicago, Ill.*

Duplex Flow Recorder with Ratio Pointer

Where panel space is at a premium, or where it is desired to have two related flow records on the same chart for ready comparison, new two-pen



Cochrane electric flow meter (actually two complete Cochrane flow meter receivers mounted within one double-depth case) achieves the result without complication and with no loss of accessibility. Both receiver mechanisms can be swung out and operate in the swung-out position. Connection between



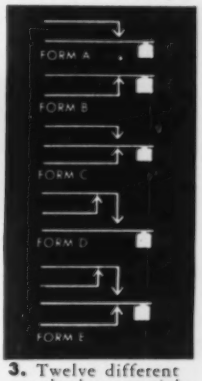
rear receiving mechanism and its pen-arm must necessarily be detachable and is arranged with a self-aligning V-notch junction. Where two related measurements are involved, operator need not note which pen is which. However, for cases where continual reference must be made to this relationship of the two records, ratio indicating pointer can be incorporated: red target moves to right or left from center point on scale to show ratio at a glance. Pointer movement, being two and one-half times difference between the two pens, is much more readily noted. Integrating feature can be furnished on both mechanisms but reading of rear mechanism integrator requires opening case and swinging front mechanism forward.—*Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.*

This CLARE Relay Can Take the Place of Many

Clare Type C d. c. Relay

■**This rugged multiple-contact relay permits innumerable contact arrangements. Permits designing to small size, with a lesser number of relays; and facilitates maintenance. Adapted for use in electronic control devices and for sequence control and interlocking operations. Ideal where unusual arrangements of relay control are desired. Here are the reasons why:**

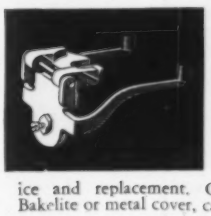
1. Contact springs employing any of the forms illustrated can be furnished.



2. Spring pile-up insulators of heat treated Bakelite which permit punching without cracks, have minimum cold flow and low moisture absorption content. Assembly locked together under hydraulic pressure. Withstands heavy breakdown tests.

3. Twelve different standard or special types and sizes of contacts can be furnished. Contacts are overall-welded to nickel silver springs. Sizes range from .062" silver, rated one ampere, 50 watts, to .1875" tungsten, rated four amperes, 500 watts.

4. Spring bushing insulators are Bakelite rod made by a patent process. Strong, hard, long wearing. Essential where heavy contact pressures are employed, where vibration exists, or heavy duty service is desired.



5. Armature assembly single or double arm. Has stainless steel shaft, operating in a marine brass yoke. Heel piece, coil core and armature are magnetic metal carefully annealed. Designed for d.c. service.

6. As illustrated, relay has octal base plug mounting for easy service and replacement. Other mountings, and Bakelite or metal cover, can be supplied.

• • •

This relay is an example of Clare "custom-built" design and construction. Clare engineers can "custom build" a relay to meet your specific requirements—one that will reduce your overall relay cost and simplify your design problem. Write for catalog and data book. C. P. Clare and Co., 4719 West Sunnyside Avenue, Chicago.

CLARE RELAYS

"CUSTOM-BUILT" Multiple Contact Relays for Electrical, Electronic and Industrial Use

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Comparator Gage for Use by Blind Persons

Thousands of blind men and women now can be recruited for war production as the result of the development of a Braille type of the "Micro-Chek" comparator inspection gage. This new type has the endorsement of the National Society for the Blind. The Braille instrument is a modification of the new

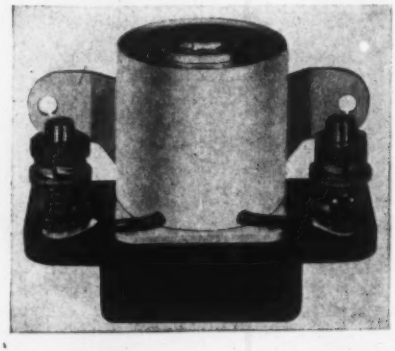
Micro-Chek (see *Instruments*, Dec. 1942, page 535) which is made with magnification factors of 60 or 200. In the Braille instrument, work-size and limit indicators all protrude through a slot, so that a finger touch reveals the movement and enables a blind inspector to determine instantly whether the part will or will not meet the tolerance requirements. New comparator is available with various types of anvils for thread-gaging, thread-lead gaging, internal dimensions, etc.—*Trico Products Corp., Buffalo, N. Y.*

Audible-signal Scale Operable by Blind Inspectors

"Audio" scale, making it possible for the blind to weigh rapidly and accurately (demonstrated at American Foundation for the Blind) operates on the airplane radio beam principle, giving the audible signal "A" as long as the sale shows under the correct weight, and the signal "N" if it registers over. Correct weight is signalled by an unbroken buzz. J. O. Kleber, electronics engineer of the Foundation; H. D. Bennett, President of the Toledo Scale Company; and Lawrence Williams, chief engineer, directed the demonstration. Mr. Kleber pointed out that in England the blind are now 100% employed. The suggestion for such a scale was originally made by a blind woman in Buffalo, and developed by scale engineers with the encouragement of the Foundation. In war plants, the scale has such uses as weighing out specific amounts of powder for fuzes, mica for radio mechanisms and buttons for uniforms. Blind operators using it are able to package certain articles more rapidly than by counting. It is expected also to prove useful to sighted persons who have to work in the dark, as in film plants, or who must concentrate on such operations as filling narrow-mouthed containers to a net weight content. A 1000-cycle a.c. flows in a tunable double-branch circuit, with an earphone coupling transformer common to both branches. A motor-driven contactor switches the current alternately to the two branches so that the intermeshed "A" and "N" pulses are applied respectively to the minus and plus fixed plates of the scale indicator balancing capacitor. At the desired weight, both signals are heard synchronized.—*Toledo Scale Co., Toledo, Ohio.*

Aircraft Solenoid Contactor

New "B-4 Type" solenoid contactor, originally designed for airplane starting motors, may be used for other applications of heavy current control. It



meets Army Air Force Specification 94-32324. It operates on 24 volts, producing a coil current of 300 milliamps. Contacts are rated at 200 amps. continuous and 800 amps. surge at 24 volts d.c. Unit has d-p.s-t. normally-open contacts, withstands acceleration and vibration over 10 *G* and operates in any position. May be disassembled with pliers and screwdriver. Metal parts are plated to withstand 200-hour salt spray test. Weight, 31 oz.—*Guardian Electric Mfg. Co., Dept. B-4-1, 1609 W. Walnut St., Chicago, Ill.*

Aircraft Solenoid Contactor

New "B-5 Series" solenoid contactor has a contact rating of 50 amps. continuous and operates on 24 volts d.c., producing a coil current of 210 milli-

amps, has d-p.s-t. normally-open contacts, weighs 11.2 oz., is built to U. S. Army Air Force Specification 94-32351, can be adapted for numerous applications of heavy current control in aircraft and other products. Unit is said to resist acceleration and vibration over 10 *G;* operates in any position; may be disassembled with pliers and screwdriver. Metal parts are plated to withstand 200-hour salt spray test.—*Guardian Electric, Dept., B-5-1, 1609 W. Walnut St., Chicago, Ill.*

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